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SAN FRANCISCO

Issued March 6, 1909.

U. S. DEPARTMENT OF AGRICULTURE,**BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 138.****A. D. MELVIN, CHIEF OF BUREAU.****INFECTIOUS ANEMIA OR SWAMP FEVER OF HORSES.****By JOHN R. MOHLER, V. M. D.,***Chief of the Pathological Division.*

Infectious anemia of horses, known also by a number of other names, as swamp fever, American surra, malarial fever, typhoid fever of horses, the unknown disease, no-name disease, plains paralysis, and pernicious anemia, has recently been the subject of much investigation. The cause of the disease has now been definitely determined as an invisible virus, which is capable of passing through the pores of the finest porcelain filters, like the infection of foot-and-mouth disease, rinderpest, hog cholera, and similar diseases. The disease is most prevalent in low lying and badly drained sections of the country, although it has been found in altitudes as high as 7,500 feet on marshy pastures during wet seasons. Therefore proper drainage of infected pastures is indicated as a preventive. It is also more prevalent during wet years than in dry seasons. It usually makes its appearance in June, and increases in frequency until October, although the chronic cases may be seen in the winter, having been contracted during the warm season.

CAUSE OF THE DISEASE.

It has been conclusively proven that infectious anemia is produced by an invisible, filterable organism which is transmissible to horses, mules, and asses by subcutaneous inoculation of blood serum. The virus which is present in the blood may be transmitted to a number of equines in a series of inoculations by injecting either the whole blood, the defibrinated blood, or the blood serum which has been passed through a fine Pasteur filter, thus eliminating all the visible forms of organismal life, including bacteria, trypanosoma, piroplasma, etc. This virus has also been found to be active in the carcass of an affected animal twenty-four hours after death.

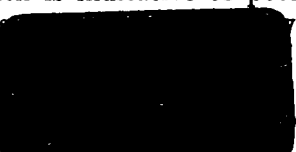
Following the injection of the infectious principle there is a period of incubation which may extend from ten days to one and one-half months, at the end of which time the onset of the disease is manifested by a rise of temperature. If uncomplicated, the infection runs a chronic course, terminating in death in from two months to one

and one-half years, or even longer. The probability of the virus being spread by an intermediate host, such as flies, mosquitoes, internal parasites, etc., is now receiving careful investigation.

From experiments already conducted it appears that this disease, formerly supposed to be confined to Manitoba and Minnesota, is more or less prevalent in Kansas, Nebraska, Colorado, Wyoming, Montana, North Dakota, and Texas. It also occurs in Europe, having been reported in Germany under the name of infectious anemia and in France as infectious typho-anemia.

SYMPTOMS.

The disease is characterized by a progressive pernicious anemia, remittent fever, polyuria, and gradual emaciation in spite of a voracious appetite. It begins to manifest itself by a dull, listless appearance and by general weakness, the animal tiring very easily. This stage is followed closely by a staggering, swaying, uncertain gait, the hind legs being mostly affected. There is also noted a weakness and tenderness in the region of the loins, and at the same time the pulse increases in rapidity and may run as high as 70, though weak, stringy, and intermittent. The temperature may rise to 103° F. or higher, remaining high for several days, and then dropping, to rise again at irregular intervals. Toward the end of the disease the temperature occasionally remains persistently high. The horse may improve for a time, but usually this temporary improvement is followed by a more severe attack than the first. Venous regurgitation is sometimes noticed in the jugular before death. The quantity of urine passed is enormous in some cases. Death finally occurs from exhaustion or syncope.

The blood shows a slight decrease in the number of white blood cells, while there is a gradual but marked diminution of red corpuscles, the count running as low as 2,000,000 per cubic millimeter, the normal count being 7,000,000. If the blood is drawn from such an animal the resulting red clot will be about one-fifth of the amount drawn. Occasionally a slow dripping of blood-tinged serum from the nostrils is observed as a result of this very thin blood oozing from the mucous membranes. Petechiæ, or small hemorrhagic points, are sometimes noticed on the nictitating membrane and conjunctiva of the eye, while paleness of the visible mucous membranes of the nose and mouth is usually in evidence, although they may have a yellow or mahogany tinge. Often a fluctuating, pendulous swelling may appear on the lower lip, point of elbow, sheath, legs, under the belly, or on some other pendant portion, especially late in the disease, which is indicative of poor circulation, thinning of the blood, and con-  action.

LESIONS.

After death the carcass is found to be very emaciated and anemic, the visible mucosa being very pale. This marked absence of adipose tissue makes the skinning of the animal a difficult task. Subcutaneous and intermuscular edema and hemorrhages are frequently observed, although it is remarkable in many cases to see how few macroscopic lesions may be present. The predominating and most constant lesion is probably the petechiæ so often observed in the muscle or on the serous membranes of the heart. The heart is generally enlarged and may be the only organ to show evidence of disease. In other cases the lungs may be studded with petechiæ, with a serous exudate present in the thoracic cavity. In addition to the petechiæ already noted, the pericardial sac generally contains an increased amount of fluid. The abdominal cavity may show peritonitis and a hemorrhagic condition of the intestines, which probably result from overfeeding in consequence of the ravenous appetite. The liver sometimes presents a few areas of degeneration, although usually normal. The spleen is at times found to be enlarged and covered with petechiæ. The kidneys may appear normal or anemic and flaccid, but microscopically they usually show a chronic parenchymatous degeneration. The lymph glands may be enlarged and hemorrhagic.

DIAGNOSIS.

The diagnosis of the disease is not difficult, especially in advanced stages. The insidious onset, remittent fever, progressive emaciation and anemia, unimpaired or ravenous appetite, staggering gait, and polyuria are a train of symptoms which make the disease sufficiently characteristic to differentiate it from other diseases affecting horses in this country. The peculiar relapsing type of fever, the great reduction in the number of red blood cells, and the absence of eosinophilia are sufficient to differentiate it from the anemias produced by internal parasites, while it may be readily distinguished from surra by the nonsusceptibility of cattle and by the great ease with which the trypanosoma may be found in the latter affection.

PROGNOSIS.

The prognosis of the disease is very unfavorable. Veterinarians in different sections of the country where it is prevalent report a mortality of 75 per cent or even higher. Recovery takes place only when treatment is begun early or when the animal has a long convalescent period.

TREATMENT.

The treatment of the disease has so far been far from satisfactory. The iodid, permanganate, and carbonate of potash have been used. Arsenic, axytol, quinin, and silver preparations have been suggested.

but all have uniformly been without success. Intestinal antiseptics have been resorted to and the results are encouraging but not altogether satisfactory. Symptomatic treatment seems to be the most dependable. For instance, Davison of this Bureau was able to reduce greatly the mortality from this affection by giving an antipyretic of 40 grains of quinin, 2 drams of acetanilid, and 30 grains of powdered nux vomica four times daily. In the late stages with weak heart action alcohol should be substituted for acetanilid. Cold-water sponge baths may be given, and in addition frequent copious injections of cold water per rectum, which has a beneficial effect in reducing the temperature and in stimulating peristalsis of the bowels, which, as a result of the disease, show a tendency to become torpid during the fever. Avoid giving purgatives unless absolutely necessary, on account of their debilitating effect, but instead give laxative, easily digestible feeds. Not infrequently a dirty yellowish tinge of the visible mucous membranes has been observed, in which cases 20 grains of calomel in from 2 to 4 drams of aloes in a ball or 2-dram doses of fluid extract of podophyllin may be given. Following the subsidence of the fever a tonic should be administered composed of the following drugs in combination:

Arsenious acid.....	grams..	2
Powdered nux vomica	do....	28
Powdered cinchona bark.....	do....	85
Powdered gentian root.....	do....	110

These should be well mixed and one-half tablespoonful given at each feed to the affected animal.

As in the case of all other infectious diseases, the healthy should be separated from the sick horses, and thorough disinfection of the infected stable, stalls, litter, and stable utensils should be carried out in order to prevent the recurrence of the disease. As a disinfectant the compound solution of cresol, carbolic acid, or chlorid of lime may be used by mixing 6 ounces of any one of these chemicals with 1 gallon of water. One of the approved coal-tar sheep dips might also be used to advantage in a 5 per cent solution (6 ounces of dip to 1 gallon of water). The disinfectant solution should be applied liberally to all parts of the stable, and sufficient lime may be added to the solution to make the disinfected area conspicuous.

Investigations are now in progress with a view of producing a vaccine or serum that will protect horses which have been exposed to the disease.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *January 29, 1909.*

[Cir. 138]



Issued April 16, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 139.

A. D. MELVIN, CHIEF OF BUREAU.

THE SCORE-CARD SYSTEM OF DAIRY INSPECTION.

BY

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THE SCORE-CARD SYSTEM OF DAIRY INSPECTION.

INTRODUCTION.

Modern investigations in dairy sanitation have shown the importance of producing and handling milk under clean conditions. An important factor in attaining that result is the score-card system of dairy inspection, which deals with itemized conditions in the dairy arranged in logical order, each of which is given a definite mathematical rating, the total number of points for a perfect dairy amounting to 100. (See p. 6.)

The system is not new. So far as the writers have been able to determine, it was first introduced and used by Dr. William C. Woodward, health officer of the District of Columbia, January 9, 1904. Following this, a somewhat different form of score card was presented by Prof. R. A. Pearson (now New York State Commissioner of Agriculture), at a field meeting in Syracuse, February 25, 1905. Both of these cards had many good features and had they been generally adopted they would have done much to improve dairy conditions.

For the past two years the Bureau of Animal Industry, through the Dairy Division, has been making a thorough investigation of the milk supply of a number of cities in different sections of the country for the purpose of establishing a system of inspection that would be practical and comprehensive and meet the demands of those who have to do with the control of the milk supply. The Dairy Division, believing the score-card system to be a practical one for the improvement of the milk supply, took up its use with the hope of extending it and securing more thorough inspection. A somewhat modified form of score card was prepared July 1, 1906, having in view its general adaptability to all sections of the country. This has been introduced and adopted in a number of cities and has been used by Dairy Division inspectors for the past two years where the division has been called upon to give assistance to health officers and inspectors in improving and controlling the supply of market milk. Some changes have been made in the card from time to time as practical experience showed where it could be improved. About 2,000 dairies have been scored by the division in all sections of the country during the past two years, and boards of health in the cities referred to have rated over 10,000 others by this system within the past year.

During the fiscal year ended June 30, 1908, the Dairy Division score card, or a slight modification of it, was adopted or used by city or State officials, creameries, dealers, etc., in 61 cities, while 79 other cities were given assistance through correspondence or visits, making a total of 140 cities that were given more or less assistance during the year. These cities are shown in the following list, those adopting the score-card system being marked with an asterisk.

California:

Hollister.
 *Los Angeles.
 Oakland.
 Pasadena.
 *Redlands.
 *Riverside.
 Sacramento.
 Salinas.
 San Bernardino.
 San Diego.
 *San Francisco.
 San Jose.
 Santa Barbara.
 Santa Cruz.
 Stockton.
 Vallejo.

Colorado:

*Boulder.
 *Colorado Springs.
 *Denver.
 *Fort Collins.
 Greeley.

Connecticut:

*Hartford.
 Orange.
 Stamford.

District of Columbia:

*Washington.

Georgia:

*Atlanta.
 Savannah.
 Waycross.

Illinois:

*Chicago.
 Harvard.
 Normal.
 Waukegan.

Indiana:

Clinton.
 *Fort Wayne.
 *Indianapolis.
 *Muncie.
 Richmond.

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Iowa:

Des Moines.
 Sheldon.

Kansas:

*Coffeyville.
 Fort Scott.
 *Hutchinson.
 Independence.
 Iola.
 *Manhattan (State dairy commissioner).
 *Parsons.
 *Topeka.
 *Wichita.

Kentucky:

Covington.
 Lexington.
 *Louisville.

Maine:

*Auburn (creamery).
 *Augusta (State dairy inspector).
 *Brunswick.
 *Pittsfield (creamery).
 *Portland.
 *Skowhegan (creamery).
 Winthrop (creamery).

Maryland:

*College Park (experiment station).

Massachusetts:

*Amherst (State college).
 *Brockton.
 *Cambridge.
 *Charlestown.
 Chelmsford.
 *Fall River.
 Haverhill.
 Salem.
 *Springfield.
 Southbridge.
 Worcester.

Michigan:

Grand Rapids.
 Jackson.

Minnesota:

*Minneapolis.
 St. Paul.

Missouri:

*Carthage.
 Greenwood.
 Hannibal.
 Jefferson City.
 *Joplin.
 Kansas City.
 *St. Louis.
 Sedalia.

Nebraska:

Omaha.
 South Omaha.

Nevada:

Reno.

New Hampshire:

*Concord.

New Jersey:

*Montclair.
 *New Brunswick.
 *Trenton.

New York:

Auburn.
 *Canton (State school of agriculture).
 Clinton.
 *Cortland.
 *Glens Falls.
 Little York.
 Lockport.
 *New Paltz.
 Olean.
 *Rochester (dairy company).
 Southampton.
 *Syracuse.
 *Yonkers.

North Carolina:	Oregon:	Utah:
*Asheville.	Portland.	*Salt Lake City.
Charlotte.	Pennsylvania:	Virginia:
Ohio:	Greenville.	Manchester.
Akron.	*Pittsburg.	*Norfolk.
Chillicothe.	Rhode Island:	*Portsmouth.
Cincinnati.	*Providence.	*Richmond.
*Cleveland.	South Carolina:	Roanoke.
*Hamilton.	Charleston.	Washington:
Middletown.	Columbia.	Bellingham.
Oberlin.	Tennessee:	*Everett.
*Sandusky.	*Memphis.	North Yakima.
*Springfield.	Nashville.	*Seattle.
Oklahoma:	Texas:	*Spokane.
Muskogee.	Dallas.	*Tacoma.
*Oklahoma.	Galveston.	Wisconsin:
Tulsa.		Milwaukee.

EFFORTS TO SECURE UNIFORMITY IN THE SYSTEM.

At the first meeting of the Official Dairy Instructors' Association, held at the State University, Urbana, Ill., July 17, 1906, a score-card committee was appointed to prepare a card which would best meet the needs of dairy inspectors, with a view to its uniform adoption throughout the country. This committee consisted of C. B. Lane, assistant chief of the Dairy Division; R. A. Pearson, State dairy commissioner, New York; and J. M. Trueman, professor of dairying, Connecticut Agricultural College. The committee prepared a card and submitted it at the second meeting of the association, held at the National Dairy Show, Chicago, October 11, 1907. The association voted to have a supply of the cards printed and distributed for trial among the heads of the various dairy departments of the agricultural colleges, reports of the results to be sent to the committee. At the third meeting of the Official Dairy Instructors' Association, held at Cornell University, July 22, 1908, the committee presented the score card in a new form, embodying as far as possible the criticisms submitted by the heads of the various dairy departments. This card, with a few minor changes, was adopted by the association, the committee still being continued so as to recommend any necessary changes at future meetings. In order, therefore, to promote uniformity in the score-card system wherever used, the Dairy Division has adopted the association card and will use it in future inspection work.

The separation of dairy conditions into equipment and methods is a strong feature of this card. The score for equipment indicates the quality and sufficiency of the tools that the dairyman has to work with, while the score for methods gives an accurate idea of the way the dairyman uses his equipment and indicates whether he is practicing right methods.

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For convenience the subject of the score-card system of inspection will be discussed under three heads: First, inspection of dairy farms; second, inspection of city milk plants and methods of distributing milk; third, inspection of the product as delivered to the consumer.

THE INSPECTION OF DAIRY FARMS.

State officials and city boards of health are generally agreed that there should be some kind of inspection of dairy farms and some kind of a standard established which every dairyman should live up to if allowed to sell milk. This being the case, the only question that remains is, What system will be most helpful to the inspector and producer and at the same time accomplish the desired result with the least amount of friction?

The objects of inspection may be stated as follows:

1. To determine in a systematic way the exact conditions in the dairies and record the same in convenient form for reference.
2. To educate the producer to better methods.
3. To protect the public from impure milk.

Two years' experience with the score-card system has given abundant proof of its merits as a means of improving the milk supply of cities, and we feel it should be a valuable aid to those officers who are held responsible for the quality of market milk. The latest form of the card is as follows:

[Front of card.]

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SANITARY INSPECTION OF DAIRIES.

DAIRY SCORE CARD.

Adopted by the Official Dairy Instructors' Association.
(Subject to revision at future meetings.)

Owner or lessee of farm: _____.
 P. O. address: _____. State: _____.
 Total number of cows: _____. Number milking: _____.
 Gallons of milk produced daily: _____.
 Product retailed by producer in _____.
 Sold at wholesale to _____.
 For milk supply of _____.
 Permit No.: _____. Date of inspection: _____, 190 _____.
 Remarks: _____

(Signed) _____, *Inspector*.

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SANITARY INSPECTION OF DAIRIES.

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[Back of card.]

DETAILED SCORE.

EQUIPMENT.	SCORE.		METHODS.	SCORE.	
	Perfect.	Allowed.		Perfect.	Allowed.
COWS.			COWS.		
Health.....	6		Cleanliness of cows.....	8	
Apparently in good health. 1					
If tested with tuberculin			STABLES.		
once a year and no tuber-			Cleanliness of stables.....	6	
culosis is found, or if			Floor.....	2	
tested once in six months			Walls.....	1	
and all reacting animals			Ceiling and ledges.....	1	
removed..... 5			Mangers and partitions.....	1	
(If tested only once a year and			Windows.....	1	
reacting animals found and re-			Stable air at milking time.....	6	
moved, 2.)			Barnyard clean and well drained	2	
Comfort.....	2		Removal of manure daily to		
Bedding.....	1		field or proper pit.....	2	
Temperature of stable.....	1		(To 50 feet from stable, 1.)		
Food (clean and wholesome).....	2				
Water.....	2		MILK ROOM.		
Clean and fresh.....	1		Cleanliness of milk room.....	3	
Convenient and abundant.....	1				
STABLES.			UTENSILS AND MILKING.		
Location of stable.....	2		Care and cleanliness of utensils.....	8	
Well drained.....	1		Thoroughly washed and ster-		
Free from contaminating			ilized in live steam for 30		
surroundings.....	1		minutes.....	5	
Construction of stable.....	4		(Thoroughly washed and		
Tight, sound floor and			placed over steam jet, 4; thor-		
proper gutter.....	2		oughly washed and scalded		
Smooth, tight walls and			with boiling water, 3; thor-		
ceiling.....	1		oughly washed, not scalded, 2.)		
Proper stall, tie, and man-			Inverted in pure air.....	3	
ger.....	1		Cleanliness of milking.....	9	
Light: Four sq. ft. of glass per			Clean, dry hands.....		
cow.....	4		Udders washed and dried.....	6	
(Three sq. ft., 3; 2 sq. ft., 2; 1			(Udders cleaned with moist		
sq. ft., 1. Deduct for uneven			cloth, 4; cleaned with dry cloth		
distribution.)			at least 15 minutes before milk-		
Ventilation: Automatic system..	3		ing, 1.)		
(Adjustable windows, 1.)			HANDLING THE MILK.		
Cubic feet of space for cow: 500			Cleanliness of attendants.....	1	
to 1,000 feet.....	3		Milk removed immediately from		
(Less than 500 feet, 2; less than			stable.....	2	
400 feet, 1; less than 300 feet, 0;			Prompt cooling. (Cooled im-		
over 1,000 feet, 0.)			mediately after milking each		
UTENSILS.			cow).....	2	
Construction and condition of			Efficient cooling; below 50° F		
utensils.....	1		(51° to 55°; 4; 56° to 60°, 2.)		
Water for cleaning.....	1		Storage; below 50° F.....	3	
(Clean, convenient, and abun-			(51° to 55°; 2; 56° to 60°, 1.)		
dant.)			Transportation; iced.....	3	
Small-top milking pail.....	3		(For jacket or wet blanket		
Facilities for hot water or steam..	1		allow 2; dry blanket or covered		
(Should be in milk house, not			wagon, 1.)		
in kitchen.)					
Milk cooler.....	1				
Clean milking suits.....	1				
MILK ROOM.					
Location of milk room.....	2				
Free from contaminating					
surroundings.....	1				
Convenient.....	1				
Construction of milk room.....	2				
Floor, walls, and ceiling.....	1				
Light, ventilation, screens.....	1				
Total.....	40		Total.....	60	

Score for equipment + score for methods = final score.

NOTE 1.—If any filthy condition is found, particularly dirty utensils, the total score shall be limited to 49.
NOTE 2.—If the water is exposed to dangerous contamination or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

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DIRECTIONS FOR USING DAIRY-FARM SCORE CARD.

The card is arranged with separate columns for "Equipment" and "Methods" and allows a total of 40 and 60 points, respectively, for each. This arrangement of points is made for the purpose of emphasizing the importance of good methods and giving unmistakable credit for cleanliness. A person may be handicapped by poor buildings which he has inherited or leased and which he can not afford to rebuild; but he can be clean. Painsstaking methods, particularly in regard to cleanliness, will give a creditable score in spite of poor equipment.

EQUIPMENT.

Health of cows.—Cows should be healthy and in good condition. A dairy cow should not be badly emaciated or have a rough, coarse coat, whether arising from insufficient feed, lack of care, or disease. The herd is scored as a whole; if one animal in the lot has a swollen jaw, inflamed udder, running sore, or ulcerated teat, a proportional deduction should be made from the herd score, unless the inspector is satisfied that the milk from such cow does not enter into the general supply. It may be seen from the card that if the herd is tested with tuberculin once a year and no tuberculosis is found, or if tested once in six months and all reacting animals are removed, the score will be considered perfect and 5 points allowed. If tested only once a year and reacting animals are found and removed, 2 points are allowed.

Comfort of cows.—A cow secretes normal milk only when she is comfortable. Her nervous system may be so disturbed that her milk will be unwholesome, especially for babies. Cows should be bedded so as to promote their comfort, especially where the floor is of concrete. Dusty or moldy hay or horse manure should not be used for bedding. The stable should be so constructed that the cow can be comfortable when the weather is inclement; wide cracks and very high ceilings should reduce the score.

Feed.—Feed should be free from mustiness or decomposition. Decaying silage, fermenting brewers' grains, distillery slops, or moldy or dusty hay should reduce the score.

Water.—Drinking water must be clean and fresh; stagnant pools do not furnish proper drinking water for cows; neither do wells so located as to receive contamination from barnyard, sink drain, or privy. Sometimes the various watering devices are so misused that the water is neither clean nor fresh.

Light.—An abundance of light destroys bacteria and promotes the health of animals. In scoring a stable for light, the number of stanchions rather than the number of cows which happen to be in the barn at the time of inspection should be considered.

Ventilation.—Ventilation means the removal of impure air and the supplying of fresh air, without drafts on the animals, and in

such a way as to conserve as much as possible the animal heat of the cows in cold weather. Consequently a stable with plenty of air space or with numerous openings to the outdoor air may be poorly ventilated. The stable should be scored for its adaptability to secure desired results when those results are needed, and not merely on conditions found at the time of the inspector's visit. A stable with open doors or with wide cracks in the sides should not be given credit for ventilation at any time. Large spaces in lofts or hay holes drawing the warmth away from the cows do not answer the full definition of ventilation, although they may afford pure air. A stable in which the cows have been kept overnight, should be comfortably warm in the morning without disagreeable animal odors. Score according to the system of ventilation in use, and see that it works properly. It will be noted on the score card that methods of ventilation that depend on the care and thoughtfulness of an attendant do not rate as high as those which are automatic.

Cubic space.—An overcrowded barn produces discomfort, is hard to keep clean, and usually results in impure air. On the other hand, an excessive amount of space for each animal tends to waste the natural heat from the cows' bodies. A proper amount of space per animal is considered to be from 500 to 1,000 cubic feet. In sections where the winters are cold deductions should be made when the space exceeds the maximum amount. In scoring for cubic feet of air space per cow consider the number of stalls rather than the number of cows which happen to be present at the time of inspection. A stable having 50 stanchions with 15,000 cubic feet of space can properly be regarded as having 300 cubic feet per cow.

Stables.—Stables should be located on well-drained land and be free from contaminating surroundings. Horse stables, pigpens, chicken coops, stagnant water, manure piles, privies, etc., when near enough to pollute the stable air, should reduce the score.

The stable should have a tight, sound floor, incapable of absorbing liquids to any extent. Back of the cows should be a gutter (preferably of concrete) of sufficient capacity to hold the droppings and keep them from soiling the cows. A gutter 14 inches wide and 6 inches deep is recommended. It should have sufficient incline to drain readily unless the liquid manure is taken up by absorbents. Some form of swing stanchion is the best kind of tie, as it allows considerable freedom and keeps the animals out of the gutter. The manger should be as simple as possible. Cumbersome constructions serve to collect dust and prevent circulation of air, and they are difficult to keep clean. A low concrete trough or a smooth floor answers the purpose and is given a perfect score. Walls and ceilings should be smooth and tight.

Utensils.—Utensils should be of tin, with as few seams as possible. Seams which are unavoidable should be flushed smooth with solder.

Rusty and battered tinware should not be used. Wire-gauze strainers should be avoided, also strainers which are complicated or have inaccessible parts, hard to clean. The water supply for washing utensils should be clean, abundant, and convenient, as the chances are against thorough cleansing when the water supply is meager or inconvenient. Impure water may convey undesirable bacteria to the utensils; hence shallow wells receiving drainage of impure water are to be regarded with suspicion. No water from wells where drainage from house wastes or barnyard is possible should come in contact with milk utensils. Small-top milk pails should be used, as they keep out dirt and do much to promote clean milk.

Milking should be done in clean suits used only for that purpose and stored in a clean place when not in use. A milk cooler should be found in every milk room, as well as facilities for an abundance of hot water or steam. A boiler with plenty of steam for scalding all utensils is the perfect arrangement; but an abundance of boiling water which can be used while it is in a boiling condition is a good substitute.

Milk house.—Every dairy should have a milk house or milk room fitted especially for the business, in which milk can be strained, cooled, bottled or canned, and stored, and in which utensils can be washed and cared for. This should be convenient to the barn, as work is usually done best under convenient conditions. The milk house or room should not be near the hogpen, manure piles, privy, or anything that might contaminate the air; if attached to the barn it should have an independent outside entrance; if entered from the barn it should be through a well-ventilated passageway with self-closing doors at each end, only one of which can be open at a time. The milk room should be light, well ventilated, and screened. Flies should never have access to milk. The floor should be smooth and of concrete, sloping so as to give good drainage; the edges should be rounded to prevent angles for collecting and harboring dirt. The walls and ceiling should be smooth and tight; concrete or tile wainscoting is desirable.

METHODS.

Cows.—Cows are reasonably clean when carefully groomed each day and when long hairs on the flanks and udders are clipped. Dust on backs, particles of manure on sides or udders, and long hairs should deduct from score.

Stable.—Stable floors should be kept clean by frequent, careful sweeping and washing. An earth floor is undesirable. Walls should be free from manure. Joists, brackets, braces, tops of stanchions, partitions, ledges, and ceilings should be clean and free from dust and cobwebs. Mangers should be clean and sweet; care should be taken that there is no dirt or fermenting feed in cracks and corners. Whitewash should be freely applied on walls, ceilings, partitions, etc. Windows should be clean.

Air in stable.—The stable air should be free from dust or odors at time of milking. It may be contaminated by horses in the stable, by hogs in the basement, by manure in a cellar, by feeding silage just before milking, or by moving hay or other dusty fodder just before milking. When inspectors can not be present at the time of milking a reasonably accurate estimate of conditions can be reached by general appearances and by questioning the person in attendance as to time and manner of feeding, etc.

Manure.—The manure should be removed daily from the stable to such a distance as to preclude the chance of odors getting back. There should be no manure in the stable yard, which should be kept clean. Where conditions are favorable the ideal way is to remove the manure daily to the field. It should not be thrown into the barnyard.

Utensils.—All utensils should be clean to superficial inspection; no particles of dirt should be found in seams or concealed places; after washing the utensils should be scalded with boiling water or steam to sterilize them. They should then be inverted in pure air to drain. The highest score can be given only where there is an abundance of steam freely used. Boiling water can be used so as to be as effective as steam, but the ordinary equipment for heating water does not provide it in sufficient quantities and of sufficient heat to sterilize the utensils.

Milking.—Methods of milking should be clean. The milker should milk with clean, dry hands. The cows' udders should also be clean; a perfect score is secured only by washing them thoroughly and then wiping dry with a clean towel. Wiping with a moist cloth is the next best thing, and wiping with a clean dry cloth gives one point on the score, if it is done several minutes previous to milking so that the dust can settle before the milking begins. If the milker after sitting down to milk gives the udder a rub with his hands or a dry cloth he may stir up dust that will fall back into the milk pail; such a method is generally worse than none.

It would be desirable to have all scoring done at milking time, but this is impracticable, as it would usually limit the work of the inspector to two or three dairies a day. Careful questioning by the inspector, with close examinations, will usually give him a fairly accurate idea of the method of milking. If, for instance, he is told that the udders are carefully washed daily, while inspection shows small lumps of manure attached to the long hairs near the teats, only one inference is possible.

Handling milk.—Milk as soon as drawn should be immediately removed from the stable so that it may absorb no odors or dust. If for convenience several milkers fill one can in the stable, a perfect score could not be given even if the can is promptly taken to the milk room when full, for it is bad practice to pour milk in the stable; but

the score should be higher under such conditions than if the milk remained in the barn till all the cans were filled. When two cows or more are milked to fill a pail, which is then taken to the milk house, the score would not be quite perfect, but would be much better than where the milk is strained behind the cows.

As soon as the milk reaches the milk room it should be cooled. This is best performed by running it in a thin sheet over a surface kept cool by ice water. Spring water of a temperature under 60° F. has much merit for cooling milk, though not as good as ice. This process is sometimes carelessly called aerating, because aeration is an incident of the cooling; but aerating as such is not in favor with the best authorities. The object of this step in handling milk is to secure prompt and efficient cooling rather than aeration, and the advantages of such cooling more than offset any possible injury from the extra exposure of the milk to the air, even if it is relatively pure. Where milk is sold by the can it is frequently cooled by setting the cans in ice water or in spring water below 60° F. This is better than no cooling, but not as satisfactory as running the milk over a cooler. Sometimes the evening milk is properly cooled, while the morning milk is delivered warm. This practice will give one-half the score for cooling providing the two kinds of milk are not mixed, in which case the score would be zero.

Storing.—This refers to conditions where the night's milk is held over for delivery in the morning. When the producer goes to the trouble and expense of two deliveries a day, that extra delivery can offset the absence of storing facilities and give him a perfect score on this item.

Transportation.—Transportation is to be scored from the same view point as stables, the adaptability of the method being the main point. It would be obviously unfair to cut a score made in midwinter because milk was not iced in transportation when the producer is in the habit of using ice in summer.

ADVANTAGES OF THE SCORE-CARD SYSTEM TO THE HEALTH OFFICER AND TO THE PUBLIC.

The experience of the Dairy Division inspectors and reports from some 60 health officers have supplied a fund of information relative to the use of the score card. Only a brief summary can be given here.

As a system of keeping records.—It gives the health officer a permanent and accurate record of all dairies in a convenient form for the office files and for ready reference in comparing not only different dairies but the same dairy inspected at different times. Score cards 5 by 7 inches are convenient in size both for filing and for use in the field.

As a basis for issuing permits.—A number of cities have set standards of 50 to 60 points which every dairyman must reach before a permit

is issued. This forces the poorer dairies to improve or go out of business, as they are given only a limited time to comply with the demands of the board of health.

Checking the work of inspectors.—The health officer can call for reports and know what his inspectors are doing every day. Further, it is practically impossible for an inspector to fill out a score card without seeing the actual conditions.

Publication of scores.—The score-card system permits of tabulating information as to conditions in the dairies so that they can be clearly shown, and by the publication of scores at intervals every dairyman is given full credit for every effort he has made to produce clean milk.

Perhaps one of the greatest drawbacks to improvement is the fact that milk from good dairies and poor dairies practically all sells for the same price. For example, dairies scoring 40 or 50 points sell their product for the same price as dairies scoring 70 or 80 points and which have incurred considerable expense in improvements. This is manifestly unfair to the producers and unbusinesslike on the part of the health departments. Publication of scores goes a long way toward correcting this state of affairs, by encouraging the better dairymen to continue to improve while calling public attention to those who are careless and slovenly. This indifferent class should be forced to fix up their places or go out of business. They are not entitled to sell milk in competition with their neighbors who are first-class dairymen.

The following illustrates the method of publishing the scores of dairies in one city:

[Extract from report of Montclair (N. J.) board of health, 1906.]

Dairyman. Dealer. ^a	Ratings.					
	Cows.	Stables.	Milk house.	Milking.	Handling of milk.	Total score.
(Perfect score).....	20	25	20	15	20	100
1.....	18	21	20	15	20	94
2.....	19	22	20	12	19	92
3.....	12	19	20	12	19	82
4.....	10	21	19	13	19	82
5.....	11	19 ^b	18	12	19	79 ^b
6.....	11	19	18	12	18	78
7.....	10	16	20	12	19	77
8.....	11	19	19	12	15	76
9.....	9	20	19	8	19	75
10.....	9	19	17	11	18	74
11.....	11	18	13	12	17	71
12.....	11	11	16	12	18	68
13.....	11	14 ^b	16	9	15 ^b	66
14.....	9	11	15	10	15	60
15.....	11	13	13	10	11	58
16.....	9	10	4	12	14	58
17.....	8	10	4	12	14	48
18.....	10	8	6	9	12	45
19.....	8	10	4	10	12	44
20.....	9	13	4	8	9	43
21.....	6	8	4	9	12	39
22.....	5	2	6	5	15	33

^a Names of dairymen and dealers are given in the report.

^b These cattle are tuberculin tested.

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Consumers who take an interest in their milk supply are not slow to note the standing of the dairies, and frequently select one that rates well even though the price of the milk may be a little higher. Naturally this encourages the dairyman who is trying to do things right and discounts the dirty and slovenly dairyman.

As a means of improving dairy conditions.—There is abundant proof that the score-card system brings immediate and permanent results wherever it is put in practice. The following quotations and records will serve to illustrate the possibilities of improvement within a short period. The table below shows the improvement in 20 dairy farms at Richmond, Va., which made the greatest percentage gain from the first score to the last one during a period of six months.

[From report of Richmond board of health, October, 1907, showing improvement in dairies during six months following introduction of score-card system.]

First score.	Last score.	Points gained.	Percentage gain.
20.0	62.5	42.5	212
31.0	70.5	39.5	127
25.5	56.0	30.5	119
27.0	59.0	32.0	117
26.0	50.5	24.5	94
30.0	55.0	25.0	83
31.0	54.5	23.5	76
35.5	61.0	25.5	72
28.5	49.0	20.5	72
26.5	44.5	18.0	68
26.5	43.5	17.0	64
36.5	59.5	23.0	63
35.0	55.5	20.5	59
39.5	61.5	22.0	56
38.5	60.0	21.5	56
41.5	61.0	19.5	47
33.0	47.5	14.5	44
43.5	61.0	17.5	40
45.5	61.0	15.5	34
48.0	64.0	16.0	33
Average..33.4	56.8	23.4	76.8

It will be noted that the average score of the dairies increased from 33.4 to 56.8, or 76.8 per cent, in six months. This furnishes a striking example of the possibilities of improving dairy conditions through the score-card system.

The first of the scores above given was the third lowest on the list at the first scoring, being only 20. This place, says the health officer, was indescribably bad. Seventeen cows were huddled into two small, dark, foul sheds, with about 200 cubic feet of air space to each cow. The water supply was grossly contaminated. The milk was poured from dirty milk pails into cans which stood in manure in a dirty stable yard. Everything was in keeping with this partial picture. This man took immediate steps to meet the requirements. His scores showed steady improvement, visit by visit, the last score showing 62.5, which is considerably above the average.

The report states that in the six months there had been built 67 new milk houses, and 12 more were ordered. Few of the dairies had "aerators" for cooling their milk; now all have them. Eleven new cow barns had been built and 8 were under construction.

Naturally all this was not done without some opposition, but with very few exceptions the most excellent feeling prevails, some who were at first most opposed to the move being now among the best friends of the health department.

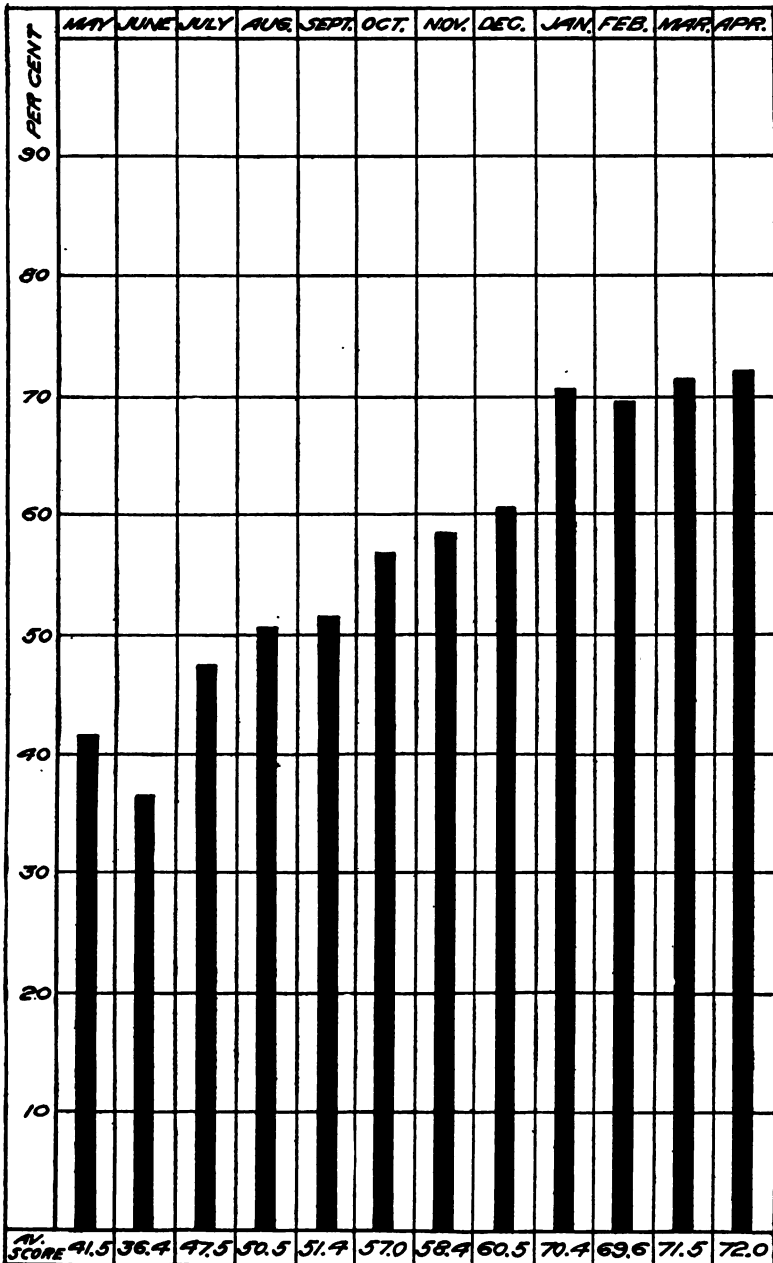


FIG. 1.—Diagram showing monthly increase in average rating of dairies supplying milk to Richmond, Va., during 1907-8. Heavy lines represent average scores of all dairies for each month.

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The improvement in the dairies supplying milk to Richmond following the introduction of the score-card system is graphically shown by the accompanying diagrams. It will be noted from figure 1 that

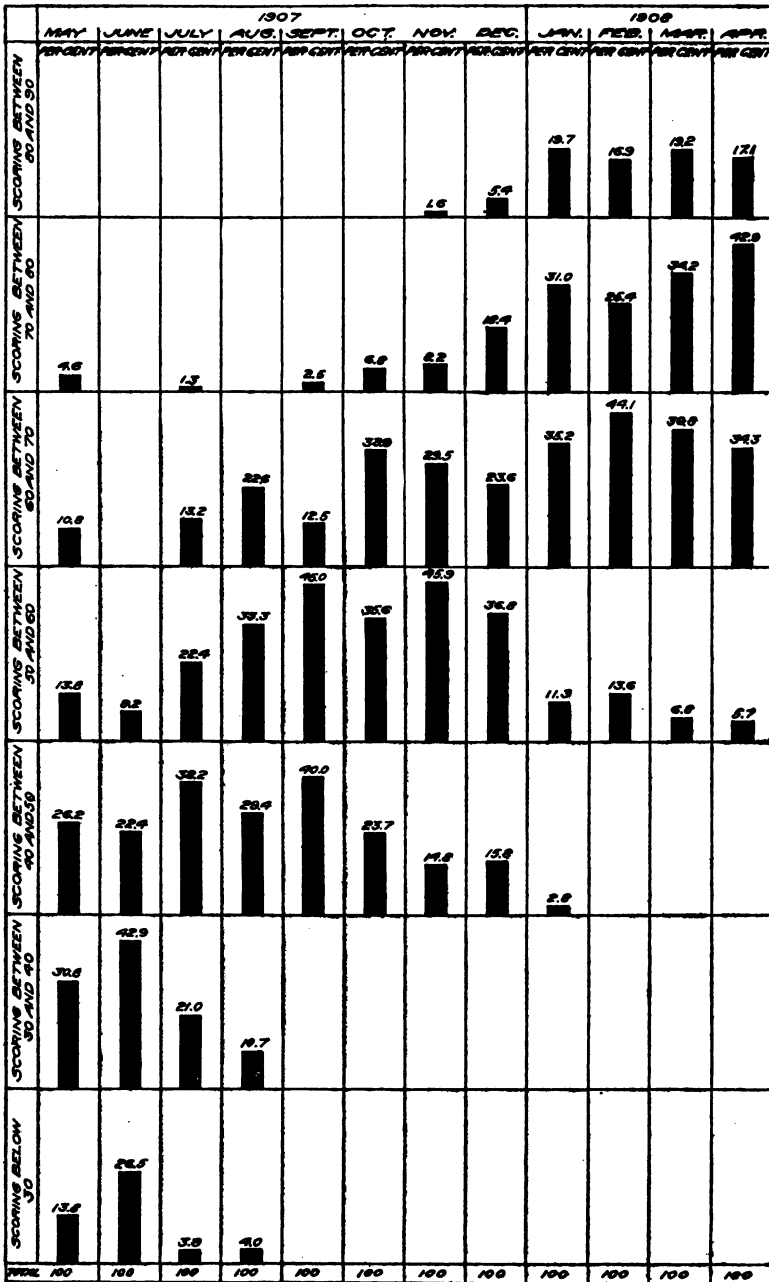


FIG. 2.—Diagram showing improvement in dairies supplying milk to Richmond, Va. Dairies are classed according to scores, the heavy lines indicating the proportion in each class from month to month.

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the average score for all dairies was 41.5 at the start and that at the end of the twelve months it had increased to 72, a gain of 30.5 points, or 71 per cent. The higher score in May than in June is due to the fact that only a part of the dairies were scored in May and those were of the better class.

Figure 2 shows the condition of the dairies supplying Richmond, classed according to their scores. The shaded columns represent the percentages of dairies found in each class in each month, the exact percentages being shown by the figures. It will be observed that the number of dairies in the classes having the lower scores gradually decreased and disappeared from month to month, while the number of dairies in the higher classes increased correspondingly. For example, dairies scoring below 40 disappeared at the end of the fourth month, while those scoring between 80 and 90 first appeared in the seventh month and reached one-sixth of the total in the twelfth month.

The Richmond health officer says:

Common justice demands that very full credit should be given to the milk producers and to the city dairymen for their share in what has been accomplished. To anyone who was familiar with the conditions under which milk was produced and sold in the city of Richmond a year ago, a visit to the dairy farms supplying us with milk at the present time would prove little short of astounding. On every hand new stables have been erected and old ones improved, milk houses have gone up, stable yards have been improved, and, most important of all, better methods of milking, handling, and transporting the milk have been introduced. Both of our large city dairies have, of their own initiative, introduced bottled milk, and, in short, methods have been completely revolutionized.

Marked improvement has also been made in the milk supply of Montclair, N. J., by the use of the score-card system of inspection, as shown by the following statement comparing conditions in 1906 with those in 1907:

[Extract from the Thirteenth Report, Board of Health, Montclair, N. J., showing improvement in dairy conditions.]

Scores.	1906.		1907.	
	Number of dairies.	Percentage of total.	Number of dairies.	Percentage of total.
90-100.....	2	4.35	4	8.0
80-90.....	2	4.35	16	32.0
70-80.....	31	67.40	25	50.0
60-70.....	3	6.50	5	10.0
50-60.....	2	4.35	0	0.0
Below 50.....	6	13.05	0	0.0
Total 70-100.....	35	76.09	45	90.0

The tabulation shows that the number of dairies scoring between 70 and 100 in 1906 was 35, or 76.09 per cent, while in 1907 the number had increased to 45, or 90 per cent of the whole. Of the 6 dairies

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that scored below 50 points in 1906, 5 have ceased to supply Montclair and the remaining 1 has so improved that it now scores 62 points. It should be noted that by this system of scoring the tuberculin test counts for 8 points and in the best dairies the application of this test has accounted for the gain in the score.

ADVANTAGES TO THE INSPECTOR.

Shows the inspector what to look for.—The score-card system is of particular value to the inspector in pointing out conditions, thus making it impossible to overlook any point of importance. All these items are kept in a permanent record by this system and comparisons can readily be made.

Incites competition.—Where the score-card system is in use there is frequently more or less competition for high scores. No dairyman wants the name of being the poorest. This competition makes it easier for the inspector to improve conditions, as his suggestions are readily heeded.

Cooperation between inspector and producer.—The system is generally well received by the dairymen, for the reason that it is clear, thorough, and absolutely fair. There is nothing mysterious about it. The inspector makes his explanations and becomes an instructor and a friend rather than an officer whose visits are to be dreaded.

Value of the system to inexperienced inspectors.—Whatever be the system of dairy inspection the inspector can not know too much about his business. Too much can not be said about the importance of competent inspectors. But with the score-card system the value of the intelligent inspector, interested in his work, is emphasized. Not only can he make a more satisfactory examination of the various details on the card and assign more accurate values to each, but in explaining his work to the dairyman he can be of great service as a teacher and helper. On the other hand, the score card is the salvation of the inexperienced, inefficient appointee, who, without some kind of a chart, would be hopelessly at sea and his work a failure. It is the evidence of competent observers in some cities that the milk supply has been improved even with poor inspectors, because they could not help securing some good results with a proper detailed score card in hand.

The score card was introduced in one large city and on examining the results of the first week's work, there being a variation of 25 points between the highest and lowest scores, the chief health officer remarked that never under the old system had the inspectors found anything to criticise or any suggestions to make in regard to the dairies scored that week; but when the results of inspection were expressed numerically, inspectors inexperienced in the use of

the score card could see and report 25-point differences. If the inspector does not attend to his business and has no interest in his work, the dairymen as well as the health officer will soon find it out. In the one or two instances where the system has failed it has been due to the inspector not desiring to compare results with his previous work.

ADVANTAGES TO THE DAIRYMAN.

Educationally.—It points out details in the production and handling of milk; makes clear what the defects are and what the ideal conditions should be. It also leads the dairyman to ask questions and to take more interest in his business.

It gives little opportunity for favoritism.—Inasmuch as each condition in the dairy has a definite number of points assigned to it the inspector is forced to be impartial, since his score once made is a permanent record of the office, and any unfairness can be at once detected if complained of by the dairyman.

It encourages confidence.—All dairymen feel that they are being treated alike.

It leads to greater profits.—More attention is given to details, which is an important economic factor in any business.

ADVANTAGES TO THE MILK DEALER.

The score-card system is of value to the dealer in assisting him to locate the better dairies, thus making it easier to secure a supply of milk to meet the demand made upon him for a good product. With a supply of good milk to handle there is less trouble with sour milk and less complaint from consumers. Many large dealers employ an inspector to give dairies supplying them with milk a rating on the basis of the score card, requiring them to reach a certain standard or stop shipping milk. To illustrate, one large milk company added the following note to the list of prices published January 1, 1908:

These prices apply only to those dairymen whose premises are scored 60 per cent or higher by the department of health. Those whose premises score less will have a reduced price paid, and milk from dairies scoring less than 50 per cent is not desired and will not be accepted.

On the other hand, some dealers are offering premiums for good dairies and good milk. One dealer in Washington, D. C., offered a bonus of 3½ cents a gallon for milk from dairies scoring 70 or above and where the cows were tuberculin tested. This same dealer offered a present of \$25 to each one of his shippers who improved his methods in such manner as to entitle him to a score of 80 points or better, in addition to giving him 3 cents a pound more for his butterfat; those scoring 70 or over were to receive \$20, and those

with 60 or over \$15, with the same advanced price for butterfat. One dealer succeeded in raising the standard of the 25 or more dairies supplying him with milk from an average of 56 points to 70 points, a gain of 14 points, or 25 per cent.

The score-card system has also been used with success in the improvement of the product sent to the creameries.

THE INSPECTION OF CITY MILK PLANTS.

City milk inspection a few years ago was merely a matter of detecting added water or preservative. With recent progress in sanitary science the work has broadened and boards of health are investigating the sanitary phases of milk production, transportation, and distribution.

In the smaller cities most of the milk consumed is retailed by the producers, and even in places of considerable size many producers are also retailers. In all cases where the functions of producer and retailer are merged in one person an inspection of the dairy farm discloses the methods of distribution as well as of production. The dairy-farm score card answers all purposes under such conditions.

As cities grow, however, the producers can not personally deliver milk to all the consumers; consequently middlemen become a necessity. These middlemen have places of business which are designated by different names in different places, but in these pages they will be referred to as "city milk plants."

These city milk plants have a wide range of capacity, equipment, and methods. At one extreme is a building 300 to 400 feet long on a spur of a railroad, where milk is received by the train load, cooled, mixed, filtered, perhaps pasteurized, canned or bottled, and held in cold storage until retailed in the city. The building has ample modern machinery for all these processes and for washing and sterilizing cans and bottles. At the other extreme is the dealer retailing only a few gallons. He may have no "plant," and his equipment may consist of only a carrier can and quart measure, which are washed in the kitchen sink with the family dishes. Or he may have fitted up the dark, illy ventilated basement of his residence as a "milk plant," with a wooden, musty tank for cooling milk, a few dozen bottles and a washtub in which to cleanse them, a dipper for filling bottles, and a brush to agitate lukewarm water inside the bottles. It does not necessarily follow that all small dealers adopt improper practices; but the chances are that the ordinary man with small capital and with only a little at stake will not take as much care as a person differently situated.

All of the varying styles of city milk plants need careful inspection, but the principles are the same as in dairy inspection: Milk should be exposed to the air as little as possible, and the air should be pure.

It should not be handled in unclean utensils, and it should always be kept cool. Based on these principles a score card for city milk plants has been devised by the Dairy Division and is used in a number of different cities. It has been found in practice to be adapted to both large and small plants. A copy of the score card follows:

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SANITARY INSPECTION OF CITY MILK PLANTS.

Owner or manager: _____. Trade name: _____.

City: _____. Street and No.: _____. State: _____.

Number of wagons: _____. Gallons sold daily: $\left\{ \begin{array}{l} \text{Milk:} \text{_____} \\ \text{Cream:} \text{_____} \\ \text{Buttermilk:} \text{_____} \end{array} \right.$

Permit or license No.: _____. Date of inspection: _____, 190 _____.

EQUIPMENT.	SCORE.		METHODS.	SCORE.	
	Per- fect.	Allowed.		Per- fect.	Allowed.
Plant:			Plant:		
Location.....	18		Cleanliness.....	15	
Convenience.....	6		Floor.....	6	
Surroundings.....	12		Cealls.....	4	
Arrangement.....	7		Wilings.....	1	
Proper rooms.....	3		Doors.....	1	
Convenience.....	4		Windows.....	1	
Construction.....	9		Good order.....	1	
Floor.....	5		Free from odors.....	1	
Walls.....	3		Machinery and utensils:		
Ceiling.....	1		Cleanliness.....	25	
Light.....	1		Milk:		
Ventilation.....	1		Handling.....	25	
Screens.....	1		(Clarifying, pasteurizing,		
Machinery and utensils:	20		cooling, bottling.)		
Kind and quality.....	7		Storage.....	20	
(Steam or hot water, bot-			45° F. or below.....	20	
tle and can washer, bottling			45° to 50° F.....	15	
machine, drying racks,			50° to 55° F.....	10	
crates, sinks, pasteurizer,					
cold storage.)					
Condition.....	7				
Arrangement.....	6				
Water for cleaning:	28				
Wagons:					
Construction, condition.....	4		Wagons:	6	
Salesroom:	11		Cleanliness.....	3	
Location.....	4		Protection of product.....	3	
Construction.....	4		Salesroom:		
Equipment.....	3		Cleanliness.....	9	
	100			100	
ADDITIONAL DEDUCTIONS.			ADDITIONAL DEDUCTIONS.		
For exceptionally bad condi-			For exceptionally bad condi-		
tions:			tions:		
.....					
.....					
.....					
Total deductions.....			Total deductions.....		
Net total.....			Net total.....		

Score for methods.....; multiplied by 2.....

Score for equipment.....; multiplied by 1.....

Total, to be divided by 3.....

Final score.....

What has been said elsewhere of the advantages of the score card in dairy-farm inspection will apply here with equal force. The merits of the system are the same on the farm as in the city milk plant, but the latter usually scores higher than the former. The average score of the District of Columbia milk plants in 1907 was 72, on the basis of 100 points for perfect. This is considerably above the average for the dairy farms supplying milk to Washington, which was 45. The difference is partially explained by the fact that the number of city milk plants is about 80, while the number of dairy farms is about 1,000. It is further explained by the fact that the city milk plant must conform to the building and plumbing regulations. Such plants are more easily reached by the inspector than the remote dairy farms. They have the regular city water supply, which is presumed to be satisfactory for cleansing utensils. They are also required to be reasonably clean; otherwise they will create a nuisance by reason of bad odors.

Similar conditions have been found to exist in other places; that is, the score of city plants is generally higher than the average for the dairies. The District of Columbia perhaps presents a condition different from that in most other places in that it has many small city plants with relatively poor equipment, with a marked deficiency of light and ventilation, with lack of facilities for washing bottles, and with a close association of family and business quarters. On the other hand, in many other cities the producers retail their own product until the growth of the place leads some person or corporation with a fair amount of capital to erect a building planned especially for the business, having modern and effective machinery, maintained in a sanitary condition, having provision for ample refrigeration, and with plenty of steam for cleansing and sterilizing utensils and bottles. Therefore many cities have only a few establishments of the grade of city milk plants which may be contrasted on the score-card basis with the dairy farms.

The average of all the plants (about 80) in the District of Columbia was 72.58; 4 per cent scored 90 or above; 16 per cent scored in the 80s; 49 per cent scored in the 70s; 25 per cent scored in the 60s; and 6 per cent scored in the 50s. On the other hand, the "average" of plants in Richmond, Va. (only one), was 87; Memphis, Tenn. (two), 74; St. Louis, Mo. (five), 73; and Hannibal, Mo. (three), 65.

DIRECTIONS FOR SCORING.

Most of the items on the score card are self-explanatory; a few, however, call for special mention. The surroundings of the plant are important. Note should be made of the more apparent objectionable features, such as the proximity of horse stables or too close connection with sleeping rooms or rooms used for domestic purposes. It should also be remembered that even a detached building in a residential

district, especially a tenement district, may have its dangers. For instance, windows may be located so as to catch the dust from rugs as they are being shaken from the windows of an adjoining tenement.

In the smaller plants all of the processes will be carried on in one room, but different rooms for handling milk and washing bottles are desirable. When a plant has several rooms the scoring will be more difficult, but the inspector must use judgment in approximating a reasonable average where there is any defective construction or insanitary condition.

The kind and quality of machinery and utensils has reference both to their efficiency and sufficiency. Under this heading the larger plants will naturally receive a better score, because of complete equipment. The arrangement of the machinery refers to its adaptability with a view to sanitary work. Convenience promotes efficient or thorough work. In considering the handling of milk, note whether it is allowed to remain in uncovered tanks, vats, bottling machines, cans, or bottles any longer than is absolutely necessary before placing in storage. Notice whether coolers, receiving tanks, and the like are protected by cheese-cloth or other covers when not located in specially constructed sanitary rooms. Note whether milk is passed through piping that can not be taken apart and properly cleaned.

The health of employees is an important consideration and should receive the careful attention of inspectors. This is not given space on the score card for the reason that where unhealthy persons are handling milk that dairy should be refused a score and compelled by the health officials to discontinue business until the cases of disease are isolated and properly quarantined if contagious.

INSPECTION OF THE PRODUCT.

The inspection of market milk in the city includes: (1) collecting samples; (2) taking temperatures; (3) examinations for dirt; (4) tests for number and kind of bacteria, pus cells, etc.; (5) tests for fat and solids; (6) tests for adulterations and preservatives.

Collecting samples.—Samples of milk should be taken at regular intervals for analysis. These should be collected largely from retail delivery wagons, so that they will represent the product received by consumers. Where the milk is bottled, sampling is a simple matter, as one bottle will suffice for a sample. Where milk is dipped from cans or drawn from faucets, sampling is not so easy. However, if the inspector puts himself in the position of a consumer, taking the product sold to him for a sample, this will represent what the dealer is actually selling. In the inspection of hotels and restaurants the best plan is to order milk at the table the same as an everyday patron, then take for analysis what is actually served. This method some-

times requires a temporary assistant who is not known to the hotel or restaurant manager. Persons collecting samples should be familiar with the manner of taking evidence in court and should be able to prove the identity of the sample delivered to the analyst. It should not pass out of sight of the inspector until personally delivered to the man in the laboratory who is to examine it, unless it is under seal and properly marked for identification. When the inspector takes several samples on a single trip, each sample should be marked as soon as taken, so that no question can be successfully raised as to the possible mixing up of the samples.

Temperature.—Many cities are now requiring that the temperature of all milk brought to or delivered within their limits must be below 50° F. An accurate thermometer is all that is necessary for the inspector to determine whether the milk comes up to this requirement.

Examinations for dirt.—This is now an important part of the work of milk inspection, and dairymen are frequently fined as heavily for dirty milk as for milk that is below the standard in fat or solids. The dirt in milk can be detected by examining the bottom of the bottle after the sample has stood for an hour. It is also determined quantitatively by means of the centrifuge, which is now a part of the equipment of the modern city laboratory.

Tests for number and kind of bacteria, pus cells, etc.—The principal value of the bacteria count in milk is as an indicator. If the number of bacteria is high this indicates that the milk has not been produced and handled under sanitary conditions; that it has not been properly cooled at the farm and in transit, or that it is too old. The bacteria count, then, is valuable in the work of milk inspection, and gives the health officer some tangible clue to the dairyman who is careless and negligent. The bacteria standards of cities vary from 100,000 to 500,000 per cubic centimeter. A few cities place a limit for the number of pus cells and carefully examine the cows in dairies where the number is large, requiring the dairyman to discontinue the milk from unhealthy animals. No attempt will be made in this publication to describe the proper procedure in examining milk for bacteria, as standard methods have frequently been published. (See Farmers' Bulletin 348, "Bacteria in Milk.")

Tests for fat and solids.—The Babcock test is the simplest method for determining the fat in milk, and the lactometer in connection with the Babcock test will give a fairly accurate idea of the total solids. Other methods that are more accurate and which require much more time may be followed where the laboratory facilities permit.

Tests for adulterations and preservatives.—The necessity for these tests is becoming less from year to year. In many cities adulterations are seldom found. Simple methods have been worked out for their detection which can be readily followed even by an inexperienced

analyst. Attention is called particularly to Bulletin 100, Bureau of Chemistry, United States Department of Agriculture, entitled "Some Forms of Food Adulteration and Simple Methods for Their Detection."

REQUIREMENTS OF A PROPER INSPECTION SYSTEM.

Present conditions indicate that a more rigid inspection is necessary and that more competent inspectors should be employed. They should be well trained along the lines of dairy sanitation and the production and distribution of milk, and capable of instructing the dairyman in all details of his work. Further, when instruction fails to bring about the desired results, there should be enough backbone in the system to enforce the regulations prescribed by the board of health and to keep all dairies up to the standard.

INSPECTION IN LARGE CITIES.

In order to do the most effective work under the score-card system some inspectors should devote their entire time to looking after conditions on the dairy farms. With farms widely scattered one inspector should be provided for, approximately, every 100. One-half of the force should be skilled veterinarians and the other half should have had good dairy training or its equivalent. The corps of inspectors should be responsible to a chief inspector whose duty it is to supervise the whole work. The chief inspector should be responsible to the health officer or commissioner. Full power should be vested in the board of health to make proper rules and regulations and to enforce the same, thus protecting the health of the public.

INSPECTION IN SMALL CITIES.

In smaller cities there will not be enough work to warrant so large a force or so much outlay as outlined above. Frequently it will be necessary for one man to inspect dairies, make the sanitary inspections in the city, take samples for evidence of adulteration, and possibly do his own chemical and bacteriological work. But even under these circumstances an inspector who is interested in his work could be trusted to inspect the farms with the score card, for he would be more or less familiar with the milk problem as a whole. Even in the smaller cities milk work should be a distinct department of the board of health and not combined with slaughter-house inspection, tenement inspection, etc.

CHANGES IN HEALTH BOARDS DETRIMENTAL.

It is unfortunate that health officers and dairy inspectors are constantly changing, as this cripples or destroys systematic work and retards improvement. Officers of health departments should be appointed under civil-service regulations.

A PLAN FOR SYSTEMATIZING DAIRY INSPECTION.^a

The following-described plan for systematizing and simplifying the work of dairy inspection is inserted for the purpose of helping cities to provide better inspection service. It is a well-known fact that many inspectors employed by cities are not well qualified for their duties, while others who may be competent lack the interest necessary to render efficient service. The methods described are calculated to assist such inspectors by illustrating the work to be performed and providing a routine course to follow.

The plan was adopted in the fall of 1907, and was devised not only for the benefit of the inspection service but for the purpose of arousing public interest in the matter with a view to bettering the quality of the milk supply.

The essential feature of the plan consists in the use of county maps, upon which are fastened studs or thumb tacks, each one representing a dairy and thus showing the exact location of all the dairies supplying milk to the city. The tacks should be of two colors, in order to distinguish between the herds that are tuberculin tested and those that are not tested, and each tack has a number on its head representing the dairyman's permit number. For convenience in the illustration, one color of tack is represented by a circle and the other by a square. The permit numbers of dairymen who have gone out of business are transferred to new dairymen as they come in. By this process the same tacks are always kept in use.

The maps used for this purpose are the standard county drawings, which can be secured for a small sum from the engineer's departments at the various county court-houses. These maps give the location of every farm in the county, with the number of acres and the owner's name; they indicate, also, every road that leads to these farms. They show in addition all the cities, towns, railroads, traction lines, rivers, and creeks; there is also a scale for measuring the distance from one place to another. In order to make a complete system it is necessary to have the maps of all the counties from which milk is shipped to the city.

The maps are placed on panels made of soft wood so that tacks may penetrate easily. These panels are hung on hinges so that they may be swung into a casing and closed to prevent dust and dirt from accumulating on the maps.

Each map should be marked with horizontal and perpendicular lines which cross and form squares on the face of the map, or these lines may be imaginary and indicated by the figures at the margin.

^a This is an original plan worked out by Dr. Lee H. P. Maynard, of the Dairy Division, while inspector for the board of health of Columbus, Ohio. It has proved valuable to both health officer and inspector.



FIG.

Each one of these lines should be numbered, the horizontal ones with odd and the perpendicular ones with even numbers, or vice versa; hence the square above line No. 1 and to the left of line No. 2 is indicated in the index by 1-2. The square above No. 1 horizontal and just to the left of No. 4 perpendicular is indicated by 1-4 in the index. By this method the location of all dairies in the county can be learned in a very short time.

The highways, railroads, and traction lines which serve as means of transportation are plainly marked on these maps, therefore it takes but a short time to determine the shortest and quickest route of inspection. The scale of the map aids in measuring the distance.

The index to the map consists of a book made similar to a loose-leaf ledger, so that old leaves can be removed and new ones inserted. The form of the index is indicated below, each sheet being ruled to contain the record of twelve months. The names are arranged in alphabetical order, space being left after each letter for the insertion of new names.

Index showing location and score of dairies and date of inspection.

Per- mit No.	Location on map.	Name.	January.		February.	
			Date.	Score.	Date.	Score.
5	3-24	Adams, J. H.....	4	62	3	68
56	17- 4	Atkinson, Charles.....	2	90	5	92
18	7-18	Barnes, L. M.....	10	71	12	74
32	5-12	Brooks, W. H.....	16	86	20	87
9	15- 6	Burrows, Daniel.....	3	79	8	81

NOTE.—The information given in the above table does not refer to the map shown in figure 3, but is intended merely to illustrate the method of keeping the index.

This index book fits in the case with the map, so that at any time it can be used to locate dairy farms.

A desirable place for the case containing the maps would be the lobby at the health office, so that when people have occasion to visit the office they would notice this public information and tell others of it. It would then become generally known that information concerning a dairy could be obtained at any time by inquiring at the health office. Again, the dairymen themselves, while renewing their permits, seeing such information and noting their standing and that it is made public, would naturally aim to raise their standard.

Milk consumers often call or telephone to the health office for information concerning the dairy which supplies them with milk, and if the dairy inspector should happen to be out the clerk would be at a loss to answer unless he could refer to a map. In large cities having a number of inspectors the chief or any one of the inspectors can not be expected to know the exact location of all the dairies, but

such information should be available. The plan described overcomes these difficulties and even enables the consumer himself to compare the condition of the dairy supplying him with milk with other dairies that supply milk to his immediate neighborhood. He could also trace for himself the route to the dairy and visit it.

SOME ADVANTAGES OF THE PLAN.

In the absence of some such system as the one described the monthly reports of inspectors to the board of health could be padded, and it would be very difficult for the board or the health officer to detect the incorrectness in inspectors' reports; but if the date, route, and scores were posted monthly in a public place dairymen would gather to ascertain how their scores compared with those of neighboring dairies, hence false reports would soon be noticed and an explanation demanded.

New inspectors, not being acquainted with the location of the dairymen, usually experience difficulty the first year in finding the dairies; in fact, the new inspector who has to locate 400 or 500 dairies scattered over three or four counties can consider the first year of his service partially wasted unless the dairies have been located by the previous inspector and a record in the form of a map left as a guide. In this way he could begin intelligently just where the former inspector's work ended.

Inspectors should aim to raise their work to a high standard, and by keeping this work before the public it will soon appreciate the value of such service. The proper scoring of dairies is a service that can not be performed by laymen, and improper scoring, if made public, will get the inspector into trouble. The map system, if adopted, would reveal the ability of an inspector as well as his daily work to the people. It will also set a standard by which successors must be guided, and if incapable their inability to render efficient service is at once manifest.

If the plan above outlined were universally adopted and maps were made of all counties in a State and a copy of each filed with the State dairy official, a complete State record could be made available, containing the number and names of the dairymen, the location and score of each dairy, also the location of all tuberculin tested herds in the State. This would assist the State dairy official in determining the counties in which his services were most needed. Similarly, complete State statistics would aid the national authorities in ascertaining the conditions existing in each State, and thereby enable them to make better laws for the protection of dairy products in interstate commerce. Such information would be of immense value also in dealing with the tuberculosis question.

THE SCORE-CARD METHOD OF RATING THE QUALITY OF MILK

The score-card system of rating milk was first used by the Dairy Division at the National Dairy Show, in February, 1906, where a milk exhibition was held under its direction. Since this national contest several States have been induced to hold similar exhibitions in connection with their dairy association meetings, including New Hampshire, Massachusetts, Pennsylvania, Ohio, Illinois, Connecticut, and Missouri. The city of Cleveland has also held two contests in cooperation with the Dairy Division and several other cities have made application for assistance in conducting like contests. The following is a copy of the score card recommended by the Dairy Division at the present time. While the system may not be practical for use of city boards of health, it has proved of great value from an educational standpoint in connection with the contests described above. (See Circular 117, Bureau of Animal Industry, United States Department of Agriculture.)

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SCORE CARD FOR MARKET MILK.

Exhibitor: _____.

Address: _____, _____.

NUMERICAL SCORE.

Flavor, 40.	Composition, 25.	Bacteria, 20.	Acidity, 5.	Appearance of package and contents, 10.	Perfect score, 100.
					Judge's score.

DESCRIPTIVE SCORE.

Flavor.	Composition.	Bacteria.	Acidity.	Package and contents.
Excellent. Good. Fair. Bad. Flat. Bitter. Weedy. Gassy. Silage. Manure. Smothered. Other taints.	Perfect. Fat, — per cent. Solids not fat, — per cent.	Perfect. Total, —. Liquefiers, —.	Perfect. — per cent.	Perfect. Foreign matter. Metal parts. Unattractive.

Remarks: _____.

Date: _____.

_____, Judge.

DIRECTIONS FOR SCORING.

FLAVOR.

If rich, sweet, clean, and pleasant flavor and odor, score perfect (40). Deduct for objectionable flavors and odors according to conditions found.

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COMPOSITION.

If 3.25 per cent fat or above and 8.5 per cent solids not fat or above, score perfect (25). Deduct 1 point for each one-fourth per cent fat below 3.25 and 1 point for each one-fourth per cent solids not fat below 8.5.

BACTERIA.

Less than 10,000 per cubic centimeter.....	(perfect)..... 20
Over 10,000 and less than 25,000 per cubic centimeter.....	19
Over 25,000 and less than 50,000 per cubic centimeter.....	18
Over 50,000 and less than 75,000 per cubic centimeter.....	17
Over 75,000 and less than 100,000 per cubic centimeter.....	16
Deduct 1 point for each 25,000 above 100,000.	.

When an unusually large number of liquefying bacteria are present, further deduction should be made according to conditions found.

ACIDITY.

If 0.2 per cent or below, score perfect (5). Deduct 1 point for each 0.01 per cent above 0.2 per cent. (If Mann's test is used, discontinue adding indicator on first appearance of a pink color.)

APPEARANCE OF PACKAGE AND CONTENTS.

If package is clean, free from metal parts, and no foreign matter can be detected in the contents, score perfect (10). Make deductions according to conditions found.

ADAPTABILITY OF THE SYSTEM TO VARIOUS SECTIONS OF THE COUNTRY.

In traveling across the country we find the dairy conditions somewhat varied, particularly in respect to climate. For example, in the New England and Central States the temperature frequently drops several degrees below zero during the winter months. This necessitates tight barns and an automatic system of ventilation, together with a reasonable amount of air space, if the animals are to be kept comfortable and healthy. On the other hand, there are sections in the South and on the Pacific coast where the stables are simply open sheds which afford all the protection necessary. Here sunlight, ventilation, and air space are unlimited and these points hardly need to be included in a score card. In such instances the boards of health have readily modified the Department score card to meet these different conditions.

THE SCORE-CARD SYSTEM AND THE CONSUMER.

Unless public sentiment demands a good quality of milk and consumers are ready to meet the increased cost, improvement must necessarily be slow. The quality of milk, then, in a large measure, rests with the consumer. The publication of the scores of the various dairies supplying a city with milk (see p. 13) gives the consumer an opportunity to know the exact conditions on the various dairy farms, and he should encourage the production of good milk by

patronizing the dairymen who have good ratings and who are trying to produce clean milk. This plan will also have a tendency to discipline the careless and slovenly dairyman and force him to improve or go out of business. It is most unjust to the producer of clean milk to be compelled to sell his product on equal terms with the producer of dirty milk. Dirty milk should not be allowed to be sold at all, but where all grades of milk are sold the price should be graded according to the quality of the goods, the same as other food products. A good way to secure wholesome milk is to refuse to patronize a dirty dairy.

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- Connecticut Bulletin 106. *Babcock Method of Determining Fat in Milk and Cream for the Use of Creameries*.
- Connecticut Bulletin 108. *Determination of Fat in Cream by the Babcock Method*.
- Connecticut Bulletin 117. *The Babcock Method of Determining the Proportion of Fat in Milk and Milk Products*.
- Illinois Bulletin 9. *Milk and Butter Tests; Milk Tests*.
- Illinois Bulletin 10. *Investigations of Milk Tests*.
- Illinois Bulletin 14. *Milk Tests; Methods of Testing Milk*.
- Iowa Bulletin 8. *The Iowa Station Milk Test*.
- Iowa Bulletin 67. *Solutions for Testing Cream and Milk*.
- Maine Bulletin 4 (new series). *Testing Cream and Milk; Fat Test and Lactometer*.
- Mississippi Bulletin 15. *Comparative Tests of Machines and Methods for the Determination of Fat in Milk*.
- Mississippi Bulletin 21. *A New Method for Testing Milk*.
- New Hampshire Bulletin 114. *The Babcock Test for New Hampshire Farmers*.
- New York (Cornell) Bulletin 17. *A Description of Cochran's Method for the Determination of Fat in Milk, for Use of Dairymen*.
- New York (Cornell) Bulletin 29. *Application of Dr. Babcock's Centrifugal Method to the Analysis of Milk, Skim Milk, Buttermilk, and Butter*.
- New York (Geneva) Bulletin 19 (new series). *A Method for the Determination of Fat in Milk and Cream*.
- North Carolina Bulletin 113. *The Testing of Milk*.

- Oregon Bulletin 70. Testing Milk and Cream.
Pennsylvania Bulletin 12. Simple Methods of Determining Fat in Milk.
Pennsylvania Bulletin 33. Directions for Using the Babcock Milk Test.
Vermont Bulletin 16. Testing Milk at Creameries.
Vermont Bulletin 21. *a*, A New Milk Test; *b*, Testing Milk at Creameries and Cheese Factories.
West Virginia Bulletin 13. The Creamery Industry—Methods of Testing Milk. Pp. 41–63.
Wisconsin Bulletin 16. New Method for Determining Fat in Milk.
Wisconsin Bulletin 24. New Method for Estimation of Fat in Milk, especially adapted to Creameries and Cheese Factories.
Wisconsin Bulletin 31. Notes on the Use of the Babcock Test and the Lactometer.
Wisconsin Bulletin 36. Directions for Using Babcock Test and the Lactometer.
Wisconsin Bulletin 52. Comparison of the Babcock Test and Gravimetric Method of Estimating Fat in Skim Milk; and Its Relation to the Dairy Industry.
Wisconsin Bulletin 156. Simple Test for Casein in Milk.
Wisconsin Station Report, 1900. Influence of Temperature on Tests of Skim Milk by the Babcock Test. Pp. 81–86.
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U. S. DEPARTMENT OF AGRICULTURE BULLETINS.

- Bureau of Animal Industry Bulletin 58. The Fat Testing of Cream by the Babcock Method. Price 5 cents.^a
Bureau of Chemistry Bulletin 100. Some Forms of Food Adulteration and Simple Methods for Their Detection. Price 10 cents.^a
Bureau of Chemistry Bulletin 107. Official and Provincial Methods of Analysis, Association of Official Agricultural Chemists. Price 20 cents.^a

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 29, 1908.*

^a These publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

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Issued April 7, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 140.

A. D. MELVIN, CHIEF OF BUREAU.

THE EGG TRADE OF THE UNITED STATES.

BY

MILO M. HASTINGS,

Scientific Assistant, Animal Husbandry Office.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., January 28, 1909.

SIR: I have the honor to transmit herewith, and to recommend for publication as a circular of this Bureau, a paper on "The Egg Trade of the United States," by Mr. Milo M. Hastings, scientific assistant in the Animal Husbandry Office of this Bureau, presenting the results of a study made during the past year of the conditions surrounding the production and marketing of eggs, with a view to determining causes of deterioration in quality and consequent loss. It appears that there is an enormous loss due to the spoiling of eggs which could be largely prevented by improved methods, and in this article the causes of such loss are pointed out and suggestions made for remedying them.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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THE EGG TRADE OF THE UNITED STATES.

INTRODUCTION.

The rapid growth of the poultry industry has lately received much attention from the press of the country. The best estimates available indicate that the income from poultry products is one of the four or five most important sources of the agricultural wealth of the nation. The recent improvements in the methods and practices of poultry husbandry and the rapid development of extensive poultry plants have also been the subject of much comment.

Although the poultry plant is steadily gaining ground in the Eastern States and also in the far West, the great bulk of the poultry wealth of the country is produced by the general farms of the Mississippi Valley, and it is also in this region that the most rapid increase in production is shown. Some idea of the rapid growth of the poultry industry in this region may be obtained from the figures for Kansas, a State where the exclusive poultry farm is practically unknown. The secretary of the Kansas state board of agriculture gives the following statistics:

Value of poultry and eggs sold in Kansas.

1903	\$6, 498, 856
1904	7, 551, 871
1905	8, 541, 153
1906	9, 085, 896
1907	10, 300, 082

In spite of the rapid increase in the production of poultry products, the supply has not kept pace with the demand. The proof for this statement is the fact that the price of eggs for the last ten or twelve years has shown not only an absolute rise but also a relative rise when compared with the general average of values of either farm crops or food products. In contrast, however, with these encouraging facts concerning the poultry industry, some critics have stated that the farmer does not realize a sufficient sum for his produce, compared with what the city consumer has to pay for strictly fresh goods, and that the quality of American eggs in the general market is decidedly inferior to that of several European countries.

The present circular is the result of an investigation of these criticisms as applied particularly to the egg crop, which constitutes about 60 per cent of the total value of poultry products.

QUALITY IN EGGS.

FRESHNESS NOT THE ONLY VITAL POINT OF QUALITY.

As a general rule, we consider freshness a desirable quality in food products. This rule is not universal, however, for, while we prefer fresh fruit, fresh fish, and fresh eggs, other articles, such as cheese and wine, are considered more desirable after an aging process.

To food products which have changed in an undesirable manner we apply the terms "stale," "soured," "decomposed," "decayed," or "rotten." If in other food products processes occur that produce a pleasant change, we speak of such food as "fermented," "cured," or "ripened." In the case of eggs all changes that take place are held in great disfavor by consumers. The two changes which cause the greatest objection are due to the development of the embryo chick or to the formation in the decaying eggs of the very foul-smelling hydrogen-sulphid gas.

Because of the readiness with which eggs spoil, the term "fresh" has become synonymous with the idea of desirable quality in eggs. However, the actual age of an egg is only one of the factors which affect the quality. An egg 48 hours old that has lain in a wheat shock during a warm July rain would probably be swarming with bacteria and be absolutely unfit for food, while another egg stored eight months in a first-class cold-storage room would be of much better quality.

HOW EGGS ARE GRADED.

Eggs are among the most difficult of food products to grade. This is because each egg must be considered separately, and because the actual substance of the egg can not be examined without destroying the egg.

From external appearance eggs can be selected for size, color, cleanliness of shell, and freedom from cracks. This is the common method of grading in early spring, when the eggs are uniformly of good quality. Later in the season the egg candle is used. In the technical sense any kind of a light may be used for an egg candle. A 16-candle-power electric lamp is the most desirable. The light is inclosed in a box or a tin cylinder, in which are made openings about the size of a half dollar. The room being darkened, the candler holds the egg to the light, large end upward, and gives it a quick turn in order to view all sides and to cause the contents to whirl within the shell.

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(See fig. 1.) To the expert this process reveals the actual condition of the egg to an extent that the novice can hardly realize. The art of egg candling can not be readily taught by worded description. One who wishes to learn it had best go to an adept, or he may begin unaided and by breaking many eggs learn the essential points.



FIG. 1.—Candling and sorting eggs. (The No. 2 quality eggs are placed in a box to the left of the candler, which is hidden from view in the picture. This picture was taken by flash light, as candling must be done in a dark place.)

VARIATION IN EGGS WHEN LAID.

Eggs when laid differ considerably in size, but otherwise are a very uniform product. The purpose of the egg in nature requires that this be the case, because the contents of the egg must be so pro-

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portioned as to form the chick without surplus or waste, and this requires a chemical composition that varies but slightly.

For food purposes all fresh eggs are practically equal. The tint of the yolk varies somewhat, being more yellow when green feed has been supplied the hens. Occasionally when hens eat unusual quantities of green feed the yolks show a greenish-brown tint and appear dark to the candle. Such eggs are called "grass eggs." They are perfectly wholesome.

An opinion exists among egg men that the white of the spring egg is of finer quality and will "stand up" better than that of summer eggs. This is true enough of commercial eggs, but the difference is chiefly, if not entirely, due to external factors that act upon the egg after it is laid.

The flavor or odor of an egg may be noticeably influenced by the feed of the hen. This has been demonstrated by feeding hens heavily on onion tops or garlic. So far as is known to the writer, no practical application has been made of this principle.

There are some other peculiarities that may exist in eggs at the time of laying, such as blood clots inclosed within the egg, a broken yolk, or perhaps bacterial contamination. The so-called "tape-worms" of eggs are detached portions of the lining membrane. "Liver spots" or "meat spots" are detached folds from the walls of the oviduct. All such abnormalities are rare, difficult to detect or prevent, and are so inconsequential when compared with the eggs which are spoiled after laying that further consideration will not be given to them.

SHELL VARIATION.

The shells of eggs vary in shape, color, and firmness. These variations are more a matter of breed and the individuality of the hen than of care or feed. The strength of eggshells is important, because breakage is a source of considerable loss to the trade. However, the difficulty of weak-shelled eggs is not one which can be easily remedied. Nothing more can be advised than to feed a ration containing plenty of mineral matter and to discard hens that lay noticeably weak-shelled or irregularly shaped eggs.

The color of eggshells is a matter in regard to which more has perhaps been said in poultry papers than the trade facts warrant. It is commonly stated that Boston and surrounding towns want brown eggs, while New York and San Francisco demand white eggs. These trade fancies probably result from the fact that there are large henneries in the respective localities producing eggs of the favored color. If the eggs from such farms are the best in the market and are uni-

formly of a particular shade, that mark of distinction, like the trade name on a popular article, would naturally become a selling point. Only the select trade, even in the cities mentioned, considers the color in buying. Uniformity of appearance in color as well as in other points pleases the eye, and for that reason and no other should distinction be made. Eggs of all Mediterranean breeds are white, those of Asiatics are brown, and those of American breeds are usually brown, but not of so uniform a tint.

SIZE OF EGGS.

The size of eggs is chiefly controlled by the breed or by selection of layers of large eggs. In a number of tests at experiment stations slight differences in the sizes of eggs have been noted with varying rations and environment, but this can not be attributed to anything more specific than the general development and vigor of the fowls. Pullets at the beginning of the laying period lay an egg decidedly smaller than those produced at a later stage in life. The average food value of large eggs is slightly greater per pound than that of small eggs because of a smaller percentage of shell in the former.

The following table gives the sizes of representative classes of eggs. These figures must not be applied too rigidly, as the eggs of all breeds and all localities vary. They are given as describing the eggs one may reasonably expect to find in the class mentioned. It should be borne in mind that the two classifications given in the table are entirely independent of each other; the breeds mentioned in the second column are not the ones which lay the eggs mentioned in the first column, though they lay eggs of the same size.

Table of representative egg sizes.

Geographical classification.	Breed classification.	Net weight per 30-dozen case.	Weight per dozen.	Relative values per dozen.
		<i>Pounds.</i>	<i>Ounces.</i>	<i>Cents.</i>
Eggs from poorest flocks of southern dunghills.	Games and Hamburgs.....	36	19½	20
Average Tennessee or Texas eggs ..	Poor strains of Leghorns	40	21½	22½
Average for the United States as represented by Kansas, Minnesota, and southern Illinois.	The mixed barnyard fowl of the western farm, largely of Plymouth Rock origin.	43	23	23½
Southern Iowa's "two-ounce eggs".	Purebred flocks of American varieties, or egg-farm Leghorns.	45	24	25
Average size of eggs produced in Denmark.	American Brahmas and Minorcas.	48	25½	26½
Selected brands of Danish eggs.....	Equalled by several pens of Leghorns in the Australian laying contest.	54	28½	30

DETRIMENTAL CHANGES IN EGGS AND CONSEQUENT LOSSES.

DIRTY EGGS.

Dirty eggs are grouped roughly in three classes—(a) “plain dirties,” those to which soil or dung adheres; (b) stained eggs, those soiled by contact with damp straw or other material which discolors the shell (plain dirties when washed usually show this appearance); (c) smeared eggs, those covered with the contents of broken eggs.

For the first two classes the farmer is to blame. The third class originates all along the route from nest to consumer. The percentage of dirty eggs varies with the season and weather conditions, being noticeably increased during rainy weather. About 5 per cent of all eggs are culled out as “dirties,” and these are sold at a loss of at least 20 per cent. This makes a financial loss of 1 per cent of the total value of the nation’s egg crop.

There is another loss caused by dirty eggs which is fully as serious. It is the loss due to the fact that in a lot of eggs so handled as to produce 5 per cent of “dirties” the remainder of the lot will show enough spotted and stained eggs to give the whole lot an inferior appearance. The amount of depreciation from this source is difficult to estimate, but it is undoubtedly as great as the direct loss on those culled out.

BROKEN EGGS.

The common trade name for cracked eggs is “checks.” “Blind checks” are those in which the break in the shell is not readily observable. These are detected with the aid of the candle or by clicking the eggs together. “Dents” are checks in which the egg shell is pushed in without rupturing the membrane. “Leakers” have lost part of the contents and are not only a loss themselves, but produce smeared eggs.

The loss from mechanical injury varies considerably with the amount of handling in the process of marketing. A western produce house collecting from grocers by local freight will record from 4 to 7 per cent of checks. These same eggs in further handling will have an additional checking of 1 to 3 per cent. Eight per cent of the eggs from hen to market is probably a fair estimate for broken eggs. The depreciation of such eggs is greater than that of dirties, being about 25 per cent. This gives a financial loss due to checks of 2 per cent.

THE DEVELOPMENT OF CHICKS (HEATED EGGS).

The laying of an egg is not analogous to birth in the case of a mammal, and the presence of the male bird is not essential for the laying

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of the egg; hence eggs laid by hens kept away from males are entirely free from the changes presented under this head.

That such infertile eggs can not spoil, however, is a mistaken notion, for they are subject to all the other factors which cause eggs to spoil. The sale of eggs tested out of incubators has been encouraged by the assertion that incubation does not spoil infertile eggs for food purposes. In practice the idea works great harm. Eggs thrown out of an incubator will be shrunk and weakened, and many of them will contain dead germs; that is, the remains of chicks that have started to develop. If the farmer's wife wishes to use such eggs at home, where she can examine the broken eggs before using, it is her own affair; but the sale of incubator eggs as fresh should not be tolerated.

Fertile eggs immediately after laying can not be distinguished from infertile eggs, the germ of the chick being microscopic in size. If the egg is immediately cooled and held at a temperature below 70° F., the germ will not develop. At a temperature of 103° F. the development of the chick proceeds most rapidly. This development is about as follows:

Twelve hours' incubation: Examined by a candle such an egg can not be distinguished from a fresh one. When broken in a saucer the germ spot, visible upon all eggs, seems somewhat enlarged.

Twenty-four hours: This egg, if not too dark shelled, can be readily detected by the professional candler, the germ spot causing the yolk to appear considerably darker than the yolk of a fresh egg. Such an egg is called a "heavy egg," or a "floater." When the egg is broken, the germ spot appears mottled and about the size of a dime.

Forty-eight hours: By this time the opaque white membrane which surrounds the germ has spread well over the top of the yolk, and the egg is quite dark or heavy before the light. Blood appears at about this period, but is difficult of detection with the candle, unless the germ dies and the blood ring sticks to the membrane of the egg.

Three days: The candle shows changes in this egg that are apparent even to a novice. An experienced candler will have no difficulty in seeing the blood ring through the shell. When broken the blood ring is the prominent feature, and is as large as a nickel. The yolk behind the membrane has become watery.

Four days: The body of the chick becomes visible to the candler, and the prominent radiating blood vessels are seen. Upon breaking the yolk is found to be half covered with the sac containing water.

The developments given above occur at a temperature of 103° F. As the temperature is lowered the rate of chick development is retarded, but at any temperature above 70° chick development will proceed far enough to cause serious injury to the quality of the eggs.

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For commercial uses the customary grouping of eggs in regard to heating is:

1. No heat shown. Can not be told at the candle from fresh eggs.
2. Light floats. First grade that can be separated by candling, corresponding to about eighteen to twenty-four hours' incubation. Not objectionable to the average housewife.
3. Heavy floats. This group has no distinction from the preceding, except an exaggeration of the same features. These eggs are objectionable to the fastidious housewife because of the white and scummy appearance of the yolk.
4. Blood rings. Eggs in which blood has developed, extending to the period when the chick becomes visible.
5. Chicks visible to the candle.

The loss to the egg trade due to heated eggs is probably greater than that from any other source. The loss varies with the season of the year and the climate. In New England heat loss may be considered as in the same class as loss from dirties and checks. In Texas the egg business from the 15th of June until cool weather in the fall is practically dead. The southerner eats few eggs at this season, and shipping out of the State nets the producer such small returns after allowance for the losses that the farmer considers it hardly worth while to gather eggs. In the unusually hot season of 1901, throughout the entire region west of the Mississippi River, hatched chickens were commonly found in cases of market eggs, and for a time the shippers did well to net 3 cents a dozen for these eggs.

During the average season the summer egg of the South and Southwest makes no pretensions to being a sound egg in regard to heat. Even in the Central West the loss is severe. An average lot of summer eggs from the Kansas-Nebraska territory would candle up about as follows:

Candled stock, containing a large proportion of light floats, 80 per cent.

Seconds, containing heavy floats and light blood rings, 15 per cent.

Absolute loss, eggs containing heavy blood rings or chicks, 5 per cent.

Some idea of the financial loss due to heated eggs can be obtained by estimating what the eggs in the above case are worth when laid as compared with what they actually bring. The best of the heated stock referred to above is worth about 5 cents a dozen less than nearly fresh eggs in the New York market. Supposing the latter to be 25 cents, there is a loss of 5 cents. The value of the seconds, which will probably be broken as bakers' stock, will not be over 15 cents. Thus we have 80 per cent at 20 cents a dozen, 15 per cent at 15 cents

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a dozen, and 5 per cent at a total loss. This makes a depreciation of 27 per cent on the original value.

In western eggs a loss due to heating or chick development of approximately one-fourth of the original value of the crop is sustained during the heated season.

The loss attributable to this element of egg deterioration is estimated at fully 5 per cent of the annual valuation of the egg crop of the country. In the East the loss would be less, while in the South it would be much greater.

The responsibility for heated eggs is almost wholly with the farmer, although the rural buyer and the freight handler are in no wise innocent.

EVAPORATION (HELD OR SHRUNKEN EGGS).

The eggshell is porous so that the developing chick may obtain air. This exposes the moist contents to the drying influence of the atmosphere, and evaporation takes place constantly. It is increased by warm temperatures, by dry air, and by currents of air striking the egg.

When the egg is formed within the hen the contents fill the shell completely. As the egg cools the contents shrink, and the two layers of membrane separate in the large end of the egg, causing the appearance of the bubble or air cell. Evaporation of water from the egg further shrinks the contents and increases the size of the air cell. The size of the air cell is commonly taken as a guide to the freshness of the egg, but when we consider that with the same humidity evaporation would take place much faster on a hot July day than on a frosty November morning, we see that the extent of evaporation from the egg proves little regarding the actual age. Even as a measure of evaporation the size of the air cell may be deceptive, for when an egg with an air cell of considerable size is roughly handled the membrane splits down the side of the egg and gives the air cell the appearance of being larger than it really is. Still rougher handling of shrunken eggs may cause the rupture of the inner membrane, allowing the air to escape into the contents of the egg. This causes a so-called "watery" or "frothy" egg. The quality is in no wise injured by the mechanical mishap, but eggs so ruptured are usually discriminated against in candling.

In this connection it might be well to discuss the subject of "white strength," by which is meant the stiffness or viscosity of the egg white. The white of an egg is a limpid liquid, but in the egg of good quality that portion immediately surrounding the yolk appears to be in a semisolid mass. The cause of this appearance is the pres-

ence of an invisible network of fibrous material. By age and mechanical disturbance this network is gradually broken down and the liquid white separates out. Such a weak and watery white is usually associated with shrunken eggs. These eggs will not stand up well or whip into a firm froth, and are discriminated against by dealers. The weakness of the yolk membranes also increases with age, and is objectionable because the breakage of the yolk is unsightly and spoils the egg for poaching.

The shrunken egg is most abundant in the fall, when the rising prices tempt the farmer and groceryman to hold the eggs. In fact, this holding is so prevalent that from August to December fresh eggs are the exception rather than the rule. While attention has been called to evaporation as the most pronounced fault of fall eggs, losses from other causes are greatly increased by the holding of eggs. If the eggs are held in a warm place, heat and shrinkage will cause the greatest loss; if held in a cellar, rots, mold, and bad odors will be the cause of a lowered price.

The loss in the egg business due to holding is perhaps least understood and appreciated by those outside the trade. This is due to the fact that the shrunken egg is not so repulsive as the rotten or heated egg. But the inferiority of the shrunken egg is so well appreciated by the consumer that high-class dealers find it impossible to use them without ruining their trade. This causes shrunken eggs to be constantly sent into the cheaper channels of consumption, with the result that all lower grades of eggs are a drug on the market in the fall of the year.

In the northern and eastern sections the farm and store holding of eggs is probably greater than it is in the South and West, and in the former sections the loss from this cause exceeds that from heated eggs. Taken the country over, the loss due to the holding for higher prices is probably about equal to the loss due to chick development.

BACTERIAL CONTAMINATION (ROTS).

In the classes of spoiled eggs which we have thus far discussed the proverbial rotten egg has not been considered. The term "rot" in the egg trade is applied in any case where an egg is absolutely unfit for food purposes. In this discussion the term "rotten egg" will be confined to the egg which contains a growth of bacteria.

The egg when laid is usually germ free, and if properly cared for will remain so. The eggshell itself is not germ proof, for the pores that admit the air for the chick to breathe are large enough to admit all forms of bacteria, but the membrane beneath the shell is germ proof as long as it remains dry. This membrane is composed of fibers crisscrossed in every direction. The dried spore of a bacte-

rium falling on this membrane would lodge in the same manner as would the body of a dead mouse upon a pile of hay; but let the right conditions of moisture and warmth be present to call the germ into activity, the membrane will be no more a barrier than the hay would be to a live mouse.

The exterior of an egg is a lodging place for bacteria and bacterial spores of all kinds, and once an egg becomes damp or is broken decomposition speedily follows. As in other products, heat favors the growth of bacteria and sufficient cold will prevent it. Unless there is moisture on the surface of the egg bacteria can not enter, and therefore dampness of the eggshell, practically speaking, is to be considered the cause of rotten eggs. Damp membranes may come from water externally applied, from the "sweating" of eggs coming out of cold storage, or from preventing evaporation to such an extent that the internal moisture of the egg thoroughly soaks the membrane. The latter occurs in damp cellars or when eggs are covered with some impervious material. Rotten eggs may be of different kinds, according to the species of germ that causes the decomposition. The specific kinds of egg-rotting bacteria have not been worked out, but the following three groups of bacterially infected eggs are readily distinguishable in the practical work of egg handling: .

1. *Black rots*.—It is probable that many different species of bacteria cause this form of rotten eggs. The prominent feature is the formation of hydrogen-sulphid gas, which blackens the contents of the egg, giving the characteristic rotten egg smell and sometimes causing the equally well-known explosion.

2. *Sour eggs or white rots*.—These eggs have a characteristic sour smell. The contents become watery, the yolk and the white mixed, and the whole egg offensive to both eye and nose.

3. *The spot rot*.—In this case the bacterial growth has not contaminated the entire egg, but has remained near the point of entrance. Such eggs are readily picked out with the candle, and when broken show lumpy adhesions on the inside of the shell. These lumps are of various colors and appearances. It is probable that spot rots are caused as much by mold as by bacteria, but for practical purposes the distinction is immaterial.

In practice it is impossible to separate rotten from partly hatched eggs, for the reason that in the typical nest of spoiled eggs found around the farm both causes have been at work. Dead chicks will not necessarily cause the eggs to decay, but many such eggs do become contaminated by bacteria before they reach the candler, and hence show complications.

The loss of eggs that are actually rotten is not as great as one might suppose. Perhaps 1 or 2 per cent of the year's output actually rots,

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but the expense of the candling and the lowering of the value of the egg crop are severe losses for which the rotten eggs are to blame. The responsibility for decayed eggs is to be shared between the farmer who allows hens to lay in the weeds or under the barn, and the dealer who holds the eggs in damp cellars or poorly managed storage rooms awaiting higher prices.

MOLDING OR MUSTINESS.

Moldy or musty eggs are caused by the accidental wetting of cases or by storage in very damp cellars or ice houses. The moldy egg is also frequently affected with spot rot. In the musty egg proper the egg meat is free from organisms, but has been tainted by the odor of the moldy growth upon the eggshell or the packing materials.

ABSORPTION OF ODORS.

The absorption of odors is the most baffling of all causes of bad eggs. Here the candler, so expert in other points, is usually helpless. Eggs, by storage in musty cellars or in rooms with citrus fruit, vegetables, fish, or cheese, may become so badly flavored as to be seriously objected to by a fancy trade, and yet there is no means of detecting the trouble without destroying the egg. Such eggs occur most frequently among the held stock of the fall season.

SUMMARY OF LOSSES DUE TO DETRIMENTAL CHANGES.

The amount of loss to the egg trade caused by needless deterioration runs into very large figures. The absolute prevention of loss can not be attained, but the estimation and classification of the cost of deterioration should serve to call attention to its extent and to show where the remedy is most needed. Summarizing from the previous discussion, we find the loss from each class as compared with the total crop value about as follows:

	Per cent.
Dirties.....	2
Breakage.....	2
Chick development.....	5
Shrunken or held eggs.....	5
Rotten eggs.....	2½
Moldy and bad flavored eggs.....	½
Total.....	17

LOSS BY CURTAILED CONSUMPTION.

Besides the loss figured above, which is based upon our present system of prices, there is a loss less tangible but none the less real; that is, the loss due to curtailed consumption. People do not like bad eggs, and if such are served to them they are inclined next time to

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order something else. This cuts down the demand and lowers the price. Any city egg dealer realizes how quickly the buying public of the better class adapts its consumption to the quality of the product. In fact there is hardly any class of consumers, however careless, but will increase consumption when the product is improved.

While the loss from curtailed consumption can not be estimated, it is readily apparent that if high quality in eggs were the rule rather than the exception it would result not only in a gain from decreasing the losses previously pointed out but in an even greater gain from an increase in the general price level.

Some idea of the difference between the amount realized for eggs as they are commonly handled and the present valuation placed on really high-grade goods may be obtained by a comparison of the actual prices realized for all eggs sold in New York City and the prices offered by a New York firm doing an extensive business in strictly high-grade eggs. The contrasted figures for the year 1907 are as follows:

Comparison of monthly average prices of total egg receipts at New York City with prices offered by a New York firm for high-grade eggs, for the year 1907.

Months.	Weighted average of prices (per dozen) at which total New York egg receipts moved.	Wholesale prices (per dozen) for strictly fresh eggs.
	<i>Cents.</i>	<i>Cents.</i>
January	25.8	42
February	24.5	40
March	19.3	32
April	16.9	30
May	16.6	31
June	15.5	32
July	15.6	35
August	17.7	38
September	20.7	40
October	21.4	42
November	26.0	45
December	27.7	42

* By weighted average is meant an average of the prices of various grades in the computation of which the relative proportion of each grade is considered.

Of course it is not possible to bring the entire egg crop of the country up to the higher values, but the fact that there is a definite market for eggs of first-class quality at almost double the prices for which the egg crop as a whole is actually sold is a point very significant to the ambitious egg producer.

THE CONSUMER'S POSITION.

The eggs of the United States are worth much more when laid than they are when they reach the consumer. Now, if they reached the consumer in good condition, he would pay a greater price and would

receive better eggs and more of them. The only change that would occur in consumption would be that the poorer consumer, who now eats low-grade eggs, would be obliged to substitute some other food for them, and that the more fortunate consumer, who now limits his consumption because of poor quality, would increase his use of eggs at the expense of other foods. The consumer would pay an extra price, but would receive full value for his extra expenditure, and would gladly welcome the change.

INCREASED GAIN TO DEALERS AND FARMERS FROM IMPROVED METHODS.

In industries where monopolies exist the burden of loss may be forced upon the producer of the raw product or the consumer of the finished article and extra profits turned into the pockets of the middleman. In the egg trade competition is open and free, and the profit of improved methods or the loss due to waste is necessarily distributed according to definite principles among all those concerned in production, transportation, and sale. The dealer's share of the increased income from better methods would be somewhat greater than his proportionate share of the increased receipts.

Suppose, as an illustration, that 15 per cent of the present valuation is the amount that goes to dealers, transportation companies, and other agencies that enter into the wholesale egg business. Under ideal trade conditions more careful methods would be used by buyers, railroad companies, and city receivers. This would require more intelligent workmen and greater expense for the facilities used. A liberal estimate for the expenses of this improved service would be one-third of the present cost of doing business, which would make a share of 20 per cent for these agencies. The increased income thus apportioned to the dealer for his reward is only 5 per cent of the value of the egg crop. This is but a small factor of the entire increase in value which we would expect under radically improved methods. It is fair to assume that the egg dealer will get a fair share of any increase in the value of the egg crop, but as his share is always a comparatively small percentage of the total value the farmer will be the chief gainer in any general rise in the final selling price.

METHODS OF MARKETING EGGS.

The method by which the larger number of American eggs pass from the producer to the consumer is as follows:

The eggs are gathered by the farmer with varying regularity and are taken, perhaps on the average of once a week, to the local village merchant. This merchant receives weekly quotations from a number of surrounding egg buyers, and at intervals of from two days to two

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weeks ships his eggs by local freight to such dealers. The dealer buys the eggs "case count;" that is, he pays for them by the case, regardless of the quality. He usually repacks the eggs in new cases and may or may not candle them.

This dealer in turn receives quotations from city egg houses and sells the eggs by wire. He usually ships in carload lots. The city receiver may also be a jobber who sells to grocers or he may sell the carload outright to a jobbing house. The jobber recandles the eggs, sorting them into a number of grades, which are sold to various classes of trade.

The foregoing method of marketing American eggs applies more especially to those produced west of the Mississippi River and marketed in the very large cities of the East.

We will now discuss the various steps of the egg trade, pointing out the reason for the existence of the present methods and their influence upon quality and consequent value.

THE COUNTRY MERCHANT.

The general store is the most common market for the farmers' eggs. This general store may be the crossroads trading place or the ambitious department store in a town of 5,000 population. Eggs, being a perishable crop continuously produced, must be marketed at frequent intervals. The trips to the general store, necessary to supply the household needs, offer the most convenient opportunity for this marketing; but there is a reason for the general merchant being an egg buyer that is more interesting and far-reaching in its effect upon the egg trade. The merchant buys eggs because by doing so he can control his selling trade. There are two reasons why the farmer trades where he sells his eggs: (1) Because it is convenient to trade at one place, and (2) because he wishes to avoid offending the merchant, which he would do if he broke the established custom of trading out the amount.

The merchant knows that to buy eggs means to sell goods, and he therefore bids for eggs. His competitors in the same town, as well as in other towns, also bid for eggs. The effect to the merchant of lowering the price of his goods or raising the price of eggs is financially the same. In either case it is the matter of cutting prices under the spur of competition. Now, the articles on which the merchant makes his chief profits are dry goods and notions. Such articles are not standardized, but their real value varies in a manner quite impossible of estimation by the unsophisticated. On the other hand, eggs are quoted by the dozen, and all who run may read.

Suppose, for illustration, two merchants in the same town are each doing business with a 20 per cent profit and are buying eggs at 10

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cents and selling for 11, the 1 cent advance being sufficient to pay for the labor of handling, incidental loss, and a small profit. One merchant concludes to cater for more trade. If he marks his goods down he will gain some extra trade, but people will fear his goods are cheap. But let him put out a placard "Eleven cents paid for eggs," and the farmers will throng his store and be less inclined to question the quality of his goods. This move having been successful, his rival across the street quietly stocks up with a cheaper line of dry goods, and one fine morning puts out a card, "Twelve cents paid for eggs," and more farm wagons will be hitched on his side of the street. The volume of business at the lower profit being insufficient to maintain two men in the town, a mutual understanding is gradually brought about by which the prices of goods sold are worked back to the basis of 20 per cent gross profit, but the false price of eggs serves to draw the trade from neighboring towns, and is maintained at the higher level.

As a matter of fact the price paid to farmers for eggs by the general stores of the Mississippi Valley is frequently 1 to 2 cents above the price at which the storekeeper sells the product. Allowing the cost of handling, we have a condition prevailing in which the merchant is handling eggs at from 5 to 10 per cent loss, and it stands to reason that he is making up the loss by adding to the prices of his goods.

Some of the effects of this system are:

1. The inflated price of merchandise is an injustice to the townspeople and to farmers not selling produce; in fact, it amounts to a taxation of these people for the benefit of the egg producers.
2. The inflated prices of the merchant's wares work to his own disadvantage in competition with mail-order or out-of-town trade.
3. The farmer who exchanges eggs for dry goods is not being paid more for his eggs, save as the tax on the townspeople contributes a little to that end, but is in the main merely exchanging more dollars.
4. The use of eggs as a drawing card for trade works in the favor of inferior produce, and the loss to the farmer through the lowering of prices thus caused is much greater than his gain through the forced contributions of his neighbors.

THE EGG SHIPPER.

The second step in the usual method of egg marketing is the sale of eggs collected by the small storekeeper to the produce man or shipper.

Throughout the Mississippi Valley there are wholesale produce houses at all important railroad junctions. A typical house will ship the produce of from one to three counties. These houses, once a week or oftener, send out postal-card quotations. These quotations read so

much per case and are usually case count, with a reservation of the privilege to reject or charge loss on goods that are utterly bad. Each grocery receives quotations from one to a dozen such houses, and perhaps from commission firms in the nearest city. The highest quotation naturally gets the merchant's shipment. The dealer repacks the eggs and usually candles them, the strictness of the grading depending upon the intended destination.

The loss in candling is generally kept account of, but is seldom charged back to the shipper. The egg man wants volume of business, and if he antagonized a shipper by charging up his loss the usual result would be loss of trade. So the buyer estimates his probable loss and lowers his price enough to cover it.

By "loss off" or "rots out" is meant the subtraction of the bad eggs from the number to be paid for. Buying on a "canded" or "graded" basis usually not only means "rots out" but that a variation of the price is made for two or more grades of merchantable eggs.

Much discussion prevails among the western egg buyers as to whether eggs should be bought "loss off" or "case count." Loss-off buying seems to be more desirable and just, but in practice is fraught with difficulties. If the loss-off buyer finds his profits small, he may instruct his candlers to grade more closely, which means he will pay less. Whether done with honest or dishonest intention, the buyer sets the price to be paid after he has the goods in his own hands, an obviously difficult commercial system.

Where the buyer in one case changes the grading basis to protect himself, there are probably ten cases where the eggs really deserve the loss charged, but the tenth chance gives the storekeeper an opportunity to nurse his loss with the belief that he has been robbed by the buyer. Such a feeling of distrust is disagreeable, and the results are that where one of two competing egg dealers buys "loss off" and the other "case count," the case-count man will get most of the business.

The case-count method being the path of least resistance, the loss-off system can only succeed where there is some factor that overcomes the disinclination of a shipper to let the other man set the price. This factor may be (1) the exceptional reputation of a particular firm for honesty and fair dealing; (2) exceptional marketing opportunities for fancy goods, enabling the loss-off buyer to pay appreciably higher rates for good stuff when subject to candling; (3) a condition that prevails in the South in the summer, where the losses are so heavy that the dealers will not take the risk involved in case-count buying; or (4) some sort of a monopoly.

The monopolistic enforcement of the loss-off system of egg buying has frequently been attempted in sections of the West by an agree-

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ment among egg men. The usual experience has been unsatisfactory. Some party to the agreement would get anxious for more business and quietly begin quoting case count, and as a result would get the business of the disgruntled shippers in his section. When one buyer begins quoting case count the remainder rapidly follow suit, and this form of buying is quickly reestablished.

THE CITY EGG DEALER.

City egg dealers are usually commission houses, but in practice most large lots of eggs are now bought by telegraph and the prices definitely agreed upon before shipment. In the larger cities egg dealing is supervised by a produce exchange or board of trade. Such exchanges frequently have rules of grading and an official inspector. This gives stability to egg dealing and for city transactions largely solves the problem of uncertainty as to quality so annoying to the country buyer. Even where official inspection is not resorted to, personal inspection by the buyer is practicable in city trading, and one may know what he is getting.

In many cases, especially in smaller cities, the receiver is the jobber, otherwise he sells the eggs that he has purchased, or that are consigned to him, to a firm that makes a business of selling them in small quantities to groceries, restaurants, etc. The jobber grades the eggs as the trade demands. In a western city this may mean two grades, good and bad; in New York it may mean seven or eight grades, the finer of these being packed in sealed cartons or each egg may be stamped with the dealer's brand.

THE CITY RETAILER.

The city retailers of eggs include groceries, dairies, butcher shops, drug stores, hotels, restaurants, and bakeries. The grade of eggs handled will, of course, vary greatly in all these classes.

The soda fountains of drug stores and the first-class hotels are among the higher bidders for strictly high-grade eggs. Many such institutions in eastern cities are supplied directly from large poultry farms. The figures at which such eggs are purchased are frequently at a given premium above the market quotation or a year-round contract price for a given number of eggs per week. This premium may range from a cent or two in western cities to as high as double the market quotations in New York or Boston. An advance of 10 cents over the quotation for extras or a year-round contract price of 35 cents a dozen might be considered typical of such arrangements in New York City.

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Another class of trade in high-grade eggs in which there has recently been encouraging developments in some cities is the retailing of eggs in wagons. This business is sometimes conducted in connection with dairy routes.

Some of the larger grocers in New York City are in the market for strictly fresh eggs and for the purpose of securing such a supply have installed departments in charge of expert egg men. Traders of this class frequently attempt to secure their supplies directly from farmers and poultry men. The great weakness of the plan is that a premium is offered which tempts the farmer to go out and buy eggs from his neighbors. The result is disastrous, for the quality becomes uncertain, and the farmer must be dropped from the list. In order to be successful such a system of buying must be based upon a grading system that will so exaggerate the premium on very high-grade goods and so depreciate any inferiority that the farmer will find it unprofitable to ship any eggs but his own or those of a neighbor who is equally reliable and who is on the inside of the deal.

The great bulk of eggs move through the channels of the small restaurant, the bakery, and the small grocery. In the smaller cities of the Central West the grocer retails eggs at a margin of 1 to 3 cents a dozen. In the South and farther West the margin is 2 to 7 cents, the retail price always being in the even nickel. In the eastern cities the grocer's margin is 2 to 5 cents.

All eggs offered for sale are usually claimed by the salesman to be "strictly fresh" or the "best," and yet the price of eggs on sale that same day in the same city may vary, if it be in April, from 15 to 35 cents, or if it be December, from 30 to 75 cents a dozen. In the large cities there exists the custom unknown in the small towns of having two or more grades of eggs for sale in the same store.

The profits of the city retailer are by far the largest item in the marketing of eggs. An approximate idea of the profits of the various handlers of eggs may be obtained from the following figures, which represent an imaginary summer shipment:

Elements of cost of a dozen eggs purchased by a New York consumer.

	Cents.
Paid the farmer in Iowa.....	15
Profit of country store.....	0
Gross profit of shipper.....	$\frac{3}{4}$
Freight to New York.....	$1\frac{1}{2}$
Gross profit of receiver.....	$\frac{1}{2}$
Gross profit of jobber.....	$1\frac{1}{4}$
Loss from candling.....	2
Gross profit of retailer.....	4
Cost to consumer.....	25

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The cheapest grade of eggs sold is taken by bakeries and by low-class restaurants. An egg when cooked with other food may have its flavor and appearance so disguised that it may be safely used, whereas if served alone it would be very repulsive. Measures have frequently been taken by city boards of health to stop the sale of "spot rots" and other low-grade eggs. The great difficulty with such regulations is that they are difficult of enforcement, because no definite line can be drawn as in the case of adulterated or preserved products. That embryo chicks and bacterially contaminated eggs are consumed by the million can not be doubted. The egg from the well-kept flock, the subsequent handling of which has been conducted with intelligence and dispatch, is the only egg whose "purity" can be assured, and the encouragement of such production and such handling is one of the most practical means by which the quality of eggs in the general market may be materially improved.

VARIATIONS IN TRADE METHODS.

From the above outline of egg marketing, any of the steps mentioned may be left out, while in other cases steps may be added. The poultry farms of the East usually ship their product direct to the city, either to a grocer or a hotel or to a dealer with a fancy trade. The ordinary farm eggs of the East, as well as many of those of Ohio, Indiana, Michigan, and Illinois, move directly from the storekeeper to the commission houses of the surrounding cities, without passing through the hands of a produce buyer. The fact that the railroad rates east of the Mississippi River are the same for small shipments as in car lots encourages this style of shipping.

In the regions of heavy egg production, both East and West, many small egg dealers buy direct from the farmers, paying a cash price. The relation of this cash price to the trade price paid at the country store varies in different localities. One cent below the country store price in trade is customary in Kansas, while in Michigan and Ohio the cash price of the dealer is usually equal to that offered at the store. The local produce dealer may occasionally buy eggs from the merchant to ship with his own, in which case he will generally allow the merchant half a cent more than his own cash price to the farmer. The presence of a cash buyer is usually coincident with the development of the poultry industry to a point where the eggs sold will more than pay the bills that a farmer would run at a general store.

The huckster or peddling wagons which gather eggs and other produce directly from the farm prevail east of a line drawn from Galveston to Chicago through Texarkana, Ark., Springfield, Mo., and St. Louis. West of this line the huckster is almost unknown.

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The huckster may be of the following types:

1. An employee of the local grocery store, trading merchandise for eggs.
2. An independent traveling peddler.
3. A cash dealer who buys his load and hauls it to the nearest city, where he peddles the produce from house to house or sells it to the city grocers.
4. An agent of a local produce buyer, working on a salary or commission.
5. A produce buyer who does not visit the farm at all, but conducts a system of rural freight service for the purpose of collecting eggs from country stores.

As far as quality of product and advantage to the farmer are concerned, the fourth style of huckster is preferable. This style exists chiefly in Indiana and Michigan and in some regions of Kentucky and Tennessee. The writer found such hucksters in southern Michigan working on a profit of half a cent a dozen, while in the mountains of Tennessee he found a huckster paying 10 cents for eggs when they were worth 18 cents in Chattanooga and 23 cents in New York.

The huckster scheme of gathering eggs would seemingly be a means of obtaining good eggs because of the advantage of regularity of collection, but in reality it does not always work out that way. While it must be admitted that in the isolated districts of the Middle and Southern States the presence of the huckster is the only factor that makes egg selling possible, it is also true that the peddling huckster of those regions usually disregards the first principles of handling perishable products. He makes a week's trip in sun and rain with his load of produce, and the result is that the quality of his summer eggs is about as low as can be found. In the more densely populated region with a daily service, or even a twice or thrice a week service, the huckster egg becomes the finest farm-produced egg in the market.

THE COLD STORAGE OF EGGS.

A very brief discussion of this subject will be sufficient for the purposes of this article.

The cold-storage egg industry is a development of the last twenty-five years. Undoubtedly the industry as a whole has been of great benefit to both egg producer and egg consumer. It has tended toward the leveling of the price of eggs throughout the year and has resulted in a large increase in the fall and winter consumption. This means a larger total demand and a consequent increase in price.

Owing to the fact that eggs are spoiled by hard freezing, they must be kept at a higher temperature than meat and butter. Temperatures

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of from 29 to 32° F. are used in cold storage of eggs. At such temperatures the eggs, if kept in moist air, become moldy or musty. To prevent this, the air in a first-class storage room is kept moderately dry, which shrinks the eggs, though much more slowly than would occur without storage. The growth of bacteria in cold storage is practically prevented. If bacteria are in the eggs when stored, the growth will be checked, but activity will begin again when the eggs are warmed up. Figure 2 shows how eggs are stored in a large cold-storage plant.

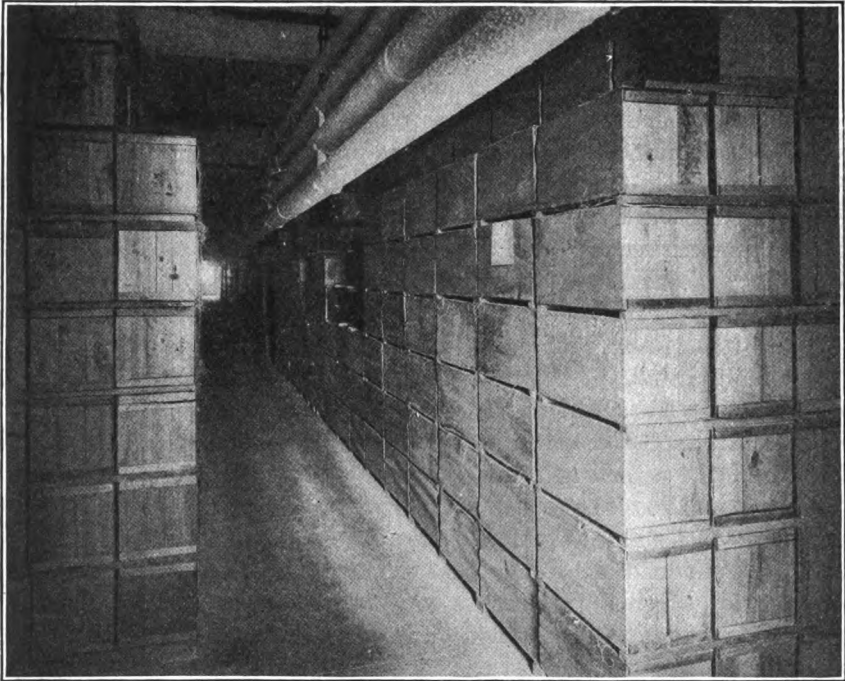


FIG. 2.—Egg room in a large eastern cold-storage plant.

Speaking generally, the cold-storage egg, while not unwholesome, is inferior in flavor and strength of white to a fresh egg. The cold-storage egg can be very nearly duplicated in gross appearance and quality by allowing eggs to stand for three or four weeks in a dry room. Cold-storage eggs, when in case lots, can be told by the candler because of the uniform shrinkage, the presence of mold on cracked eggs, and, perhaps, the occasional presence of certain kinds of spot rots peculiar to storage stock; but the absolute detection of a single cold-storage egg by candling is, so far as the writer knows, impossible.

With the present prevailing custom of holding fall eggs without storage facilities, it is frequently true that eggs placed in cold storage

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in April are superior to current fall and early winter receipts. Cold-storage eggs are usually sold wholesale as cold-storage goods, but are retailed simply as "eggs."

The fall eggs offered to the consumer cover every imaginable variation in quality, and the poorest ones sold may or may not be cold-storage stock.

PRESERVING EGGS BY OTHER MEANS THAN COLD STORAGE.

Occasional articles have been printed in agricultural papers calling attention to the fact that the cold-storage men were reaping vast profits which rightfully belonged to the farmer, and advising the farmer to send his own eggs to the storage house or to preserve them by other means. As a matter of fact, the cold storage of eggs has not of late years been particularly profitable, there having been severe losses during several seasons. Even were the profits of egg storing many times greater than they are, the above advice would still be unwise, for the storing, removing, and selling of the farmer's individual case of eggs would eat up all possible profit.

When eggs in the hands of large operators are properly preserved in cold storage, the best and most efficient methods known are in reality at the farmer's service. Because of the severe competition that prevails in egg storing, the farmer is paid all the increase in price which the business will stand. A comparison of the summer prices of eggs now with summer prices before days of cold storage will substantiate the truth of this statement.

As for other methods of egg preservation, including the much recommended water glass or sodium silicate, it should be said that eggs may be successfully preserved by such means, and there can be no objection offered against the farmer preserving eggs in this manner for his own use. Such methods of egg preservation have been much sought after by experiment station workers and others interested in the farmer's welfare, but a study of the egg trade shows that efforts along this line have really acted as a boomerang and in the long run have caused more loss than gain to egg producers. The reason for this lies in the fact that in common practice efforts at egg preservation are frequently failures, and at best they result in the dumping on the market of what is known in the egg trade as "pickled eggs." These eggs must not only be sold at a low price themselves, but their presence casts suspicion on all eggs, thus tending doubly to suppress the price paid to the farmer.

Although an individual farmer may appear to make a few cents by holding or pickling his eggs, the gain is apparent only, for the destruction of wealth involved in the injury to the quality of the egg must, as has already been shown, be borne by the farmer himself.

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Above all else, the infallible rule concerning the marketing of eggs is for the farmer to sell his eggs as soon as possible after they are laid.

HOW TO EFFECT IMPROVEMENT.

Stopping the loss in our egg trade would pay abundantly, but under our present system the reward for individual effort is shared by all, and the loss due to carelessness and dishonesty is also borne by all. If eggs are to be well handled, every man who handles them must know that he is being paid for his extra pains.

To save the millions of dollars which are carried down our sewers in the shape of bad eggs we must have, first, a campaign of education among egg producers that will show every farmer's wife that when eggs are allowed to remain in damp nests, under broody hens, or in hot kitchens there is a loss of quality which means an actual loss of money to herself and to her neighbors; and, secondly, a system of buying eggs that will as nearly as possible recompense every producer who sells eggs exactly in accordance with what those eggs are worth.

PURE-FOOD LAWS.

During the summer of 1907 the pure-food commissioner of Minnesota issued placards putting rotten eggs under the ban of the pure-food law. Several arrests of farmers and dealers were made, the parties invariably pleading guilty. In 1908 a number of Western States followed the example of Minnesota in challenging the sale of rotten eggs. The degree to which this movement was carried depended upon the efficiency of the organization of the several pure-food departments or commissions.

For the enforcement of such laws dependence can not be placed upon the dealers. If a merchant receives a lot of inferior eggs from a wealthy farmer whose trade is worth many times the value of the eggs, it is useless, under the present competitive conditions, to expect the merchant to act as complainant and prosecuting witness. In enforcing such laws it is of value to have food inspectors who are trained as practical egg candlers and whose testimony, together, perhaps, with that of some disinterested witness, before whom the bad eggs may be broken, would be sufficient evidence in court.

One of the advantages of such laws is that they call the attention of the farmer to the wrong that he may be carelessly committing and create a fear of a possible disgrace by arrest and prosecution.

BUYING ON A QUALITY BASIS.

The readiness with which the loss is brought home to a producer selling his eggs directly to a fancy trade is apparent. The extension of such trade is certainly desirable from this standpoint, but with

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the exception of a few favorably located individuals this plan is impracticable. The sale of the farmer's eggs directly to city dealers with a fancy trade is almost as efficient a method as selling directly to the consumer, but in this case the fear of losing the farmer's shipments becomes a factor in making the receiver less strict in the matter of holding the producer to a high standard. This method, like the former, is limited in application to regions near our best consuming centers.

The next step involves the local buyer in the community where the eggs are produced. If the buyer who buys from the farmer is also the shipper to the final market the problem is not difficult. In this case the farmer should be paid for quality and given an opportunity to see the inspection of his own eggs.

Such a scheme works nicely where the buyer has a monopoly, but where he has competition he finds it difficult to hold his trade. The farmer does not realize the effects of his own carelessness, and considers it impertinent to question the quality of his produce. As it requires time to produce improvement in a neighborhood, and the small buyer's goods will be considered ordinary until he has forced recognition of their extra quality, he will at first have difficulty in paying sufficient excess over his competitor to overcome the farmer's antagonism for the quality buying; hence the frequent failure of this plan.

It seems unfortunate that the farmers of a community having an enterprising buyer do not realize the advantage that would accrue to themselves from the establishment of a system of quality buying and the consequent upbuilding of the reputation of the community as a source of high-grade eggs.

In more remote and less productive regions the problem is not as easy of solution. Here there are fewer towns that can support an establishment buying direct from the farmers, and freight rates oblige such a buyer to sell to a car-lot shipper, thus lessening the chances of his receiving full valuation for his better eggs. Such localities have two distinct problems in quality buying: (1) How to pay the farmer on a quality basis; (2) how to pay the man who buys from the farmer on a quality basis.

Clearly the buyer must be able to get more for good eggs than for bad eggs before he can be asked to make a distinction to the farmer. This involves the question of "loss-off" buying, the difficulties of which have already been discussed. The shipper can not afford to pay much extra to an occasional dealer buying "loss off" from the farmer, as the small shipment of high-grade goods would be run in with a carload of store receipts and its identity lost.

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There should be, however, within shipping reach of every community some city of such size that grocers could be found who, at least during the summer and fall months, would pay a sufficient advance for a high grade of eggs to make it profitable for a local buyer to deal on a quality basis.

REMEDIES FOR THE GENERAL-STORE EVIL.

The general store, where the great majority of the eggs first leave the farmers' hands, is above all the weakest spot in the industry. The merchant can not candle, for he has not time, facilities, or knowledge; and what is still more significant, he does not want to candle, if he can help it, because the farmers' trade is worth more than the loss on the eggs, and as long as competition exists the first effect of candling will be to disgruntle the farmers and lose their trade.

The evil of the general store is not alone because it does not buy on a quality basis, but because, in order to hold the farmers' trade in dry goods, it bids up the price on eggs, case count, until the loss-off buyer can not do business.

The following are suggested as remedies for the evils of the general-store system of buying eggs:

1. Establishment of a case-count cash buyer. The establishment of a cash market is a distinct step in advance. It makes the farmer independent of the trade market, and brings him in contact with a man who will be more liable to educate him in the production of high-grade produce. The cash buyer is at present established in all the larger country towns east of the Mississippi River and north of Tennessee. In the West cash buyers are less frequent, but the system is spreading rapidly. The chief difficulty is the unduly high level of prices at the stores, which makes it hard for the cash buyer to pay enough to get a reasonable share of the goods.

2. A cash dealer, buying loss-off from the farmer. This plan, already discussed, is a distinct improvement of the case-count buyer, but is still more difficult of establishment. It is rarely found west of Indiana.

3. The agreement of the merchants to turn all egg buying over to the produce buyer. This has been successfully done in a few instances, but there are not many towns in which those interested will stick to such an agreement. The worst fault with this plan is that when the egg buyer is given a monopoly he is tempted to lower the farmers' prices for the purpose of increasing his own profits. Even if this is not done the competition of neighboring towns where trade prices are on a high level is a very serious handicap. In the long run the town with the loss-off buying and the cash market should be able to give

better prices than the more negligent competing point, but these fights hinge on immediate and not ultimate prices.

4. The buying of eggs at the creameries has been much talked of. The greatest difficulty in this has been the opposition of the merchants, who through numerous ways available in a small town may retaliate and injure the creamery patronage to an extent greater than the newly installed egg business will repay.

5. Another plan is a modification of the preceding, in which the produce buyer is on a salary. This scheme has been successfully carried into effect in some Nebraska towns, and to the writer seems to be the most hopeful solution of the egg-buying problem. It eliminates the temptation of the buyer to use his privilege of monopoly to fatten his own pocketbook. The weakness of the plan is that a salaried man's efficiency in the close bargaining necessary to sell the goods is inferior to that of the man trading for himself. This might be remedied by having the determination of price to be paid and the negotiation of the sale of the product left to one of the merchants in the association. Other difficulties are the getting together of a group of merchants who will live up to such an agreement; the objection of the farmers to driving to two places; the competition of other towns; the merchant's realization that the farmer with cash in his pocket or a check good at all stores is not as certain a trader as one standing, egg basket on arm, before the counter; and last and most convincing, the merchant's further realization that any fine Saturday morning, with eggs selling at 15 cents at the produce house, he may stick out a card "Sixteen cents paid for eggs" and make more money in one day than his competitors have made all the week.

6. Cooperation among farmers has made less headway in the United States than in other countries. The two chief examples of its success here are the fruit trade of California and the cooperative creameries, of which some 2,200 are in operation at the present writing. To the writer's personal knowledge, there is only one farmers' cooperative egg-marketing association in existence in the United States, and that has been kept up more from a desire to adhere to a principle than because the members were financially reimbursed for their extra trouble.

About one-half the egg business of Denmark is handled by co-operative egg-export societies, which proves that such a method of egg marketing can be successfully carried on. The other half of the Danish egg trade is handled by private dealers, who are equally severe in rejecting bad eggs and maintaining the quality, from which we may judge that the system of egg handling by private dealers is also capable of putting out a high grade of eggs.

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Whatever may be the means by which improvement in the egg trade is brought about, some form of regular gathering of the eggs is essential, and for this purpose in all thickly settled regions the house-to-house wagon is the best.

It must not be thought, however, that the huckster wagon, without good management back of it, is a cure for the evils of the present situation. If the huckster capriciously puts the price up and down and the farmer holds his eggs from week to week to catch the huckster at the best time, the system is no better than the grocery-store trading.

BUYING EGGS BY WEIGHT.

Much has been said of buying and selling eggs by weight. As far as selling to the consumer is concerned, the present method is more feasible, namely, to grade according to the size and other qualities and sell by the dozen according to the grade.

In Denmark all eggs are bought from the farmers by weight and sold by the dozen in standardized grades. Some form of discrimination against small eggs is undoubtedly a part of the needed reform in buying eggs from the producers. This discrimination may be brought about by buying by weight, by docking all lots of eggs of less than a certain average weight, or culling out all eggs less than a given weight or size and paying a considerably lower price for these culls. Any of these ways would speedily result in weeding out the flocks of hens laying small eggs.

REQUISITES FOR THE PRODUCTION OF GOOD EGGS.

As requisites for the production of good eggs and marketing them in good condition the following may be mentioned:

1. Hens that produce not only a goodly number of eggs but eggs of moderately large size (weighing 2 ounces each on an average). Plymouth Rocks, Wyandottes, Rhode Island Reds, Orpingtons, and Leghorns or Minorcas that are used on egg farms are varieties that may be expected to do this.
2. Good housing, regular feeding and watering, and, above all, clean, dry nests.
3. Daily gathering of eggs, and, when the temperature is above 80°, gathering twice a day.
4. The confining of all broody hens as soon as discovered.
5. The rejection as doubtful of all eggs found in a nest that was not visited the previous day. Such eggs should be used at home, where each may be broken separately.
6. The placing of all summer eggs, as soon as gathered, in the coolest place available.

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7. The prevention at all times of moisture in any form coming in contact with the eggshells.

8. The disposal of young cockerels before they begin to annoy the hens. Also the selling or confining of old male birds from the time hatching is over until cool weather in fall.

9. The using of cracked and dirty as well as small eggs at home. Such eggs, if consumed when fresh, are perfectly wholesome, but when marketed are discriminated against and are likely to become an entire loss.

10. The marketing of all eggs at least once a week, and oftener when convenience allows.

11. Keeping eggs as cool and dry as possible while on the way to town and while in country stores.

12. Keeping eggs away from musty cellars or bad odors.

13. The use of strong, clean cases and good fillers.

14. The shipping of eggs to the final market at least once a week and as much oftener as possible.

GENERAL SUMMARY.

I. The loss in this country due to the actual spoiling of eggs constitutes an enormous waste, which could in a large measure be saved were eggs given reasonable care from the time of laying until they reach the consumer.

II. There are two main reasons why such care is not being given: (1) Lack of realization of the importance of the egg crop and ignorance of the correct method of caring for the product; (2) because with our present system the individual farmer, and in the West the individual storekeeper as well, are not financially rewarded for their greater pains nor held accountable for gross carelessness, which may amount to actual dishonesty.

III. The ideal condition of the egg trade is to bring the intelligent dealer who wants quality and will pay for it into close touch with the producer. Every factor in the egg trade that prevents this is detrimental to the progress of this important branch of intensive agriculture.

IV. The greatest handicap to the egg trade is the general store, with its custom of bartering merchandise for eggs. The storekeeper reckons his profits on goods as more than his loss on eggs. He does not try to enforce improvement upon his patrons by buying on a quality basis, and by the advantage his peculiar position gives him he keeps other egg buyers from doing so.

V. The cure for this evil consists in teaching the farmer and the merchant that the present method of trading is upon a false basis,

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which is of no real advantage to either, but is in reality a great disadvantage to both in that it causes an actual loss of wealth which must be borne by the community. When such an understanding is established the community is ready for some plan of buying eggs that will pay the producer in accordance with the actual worth of the product. This done, and a market found where the improved goods will be recognized and paid for, the future of the egg and poultry industry in that community is simply a matter of patience and perseverance.

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FOOT-AND-MOUTH DISEASE.^a

By D. E. SALMON, D. V. M., and THEOBALD SMITH, M. D.

[Revised by D. E. Salmon, D. V. M., and John R. Mohler, V. M. D.]

NATURE AND LOSSES.

This disease is also known as epizootic aphtha, aphthous fever, infectious aphtha, eczema epizootica, and may be defined as an acute, highly contagious fever of a specific nature, characterized by the eruption of vesicles, or blisters, in the mouth, around the coronets of the feet, and between the toes.

The tremendous ravages of the disease are seen in the number and variety of species attacked. While it may be regarded as essentially a disease of cattle, hogs would seem to be as easy a prey. Almost in the same grade of receptivity come sheep and goats. Next in order of liability come the buffalo, American bison, camel, deer, chamois, llama, giraffe, and antelope. Horses, dogs, cats, and even poultry have been victims of the infection, the last three classes being particularly dangerous as carriers of the contagion. Man himself is not immune, and the frequency of his infection by coming in contact with the diseased animals themselves is established by numerous observations. Children suffer as a result of drinking the unboiled milk from infected cattle. In such cases the symptoms resemble those observed in animals. There is fever and difficulty in swallowing, followed by an eruption of blisters in the mouth and very rarely by similar ones on the fingers. The disease is very seldom fatal, and chiefly restricted to children and to those adults who handle sick animals or drink large quantities of unboiled milk. Some veterinarians regard the human affection as by no means uncommon in countries where foot-and-mouth disease prevails, but that the disturbance of health is usually too slight to come to the notice of the family doctor.

The disease prevails in European countries and occasions great losses. Although the actual mortality is quite low, serious losses

^a Reprinted (with slight revision) from Special Report on Diseases of Cattle, 1904.

result from the diminution of the milk secretion and consequent interference with the business of the dairy. There is likewise more or less loss of flesh in animals.

Every appearance of foot-and-mouth disease upon American soil has been quickly followed by the total suppression of the disease, and it will therefore be necessary to go abroad for evidences of the devastation which always follows in the wake of an outbreak of this scourge and for estimates of the loss which it entails upon the farmers and stock owners in affected districts.

According to the very accurate statistics collected by the German Empire, 431,235 head of cattle, 230,868 sheep and goats, and 153,808 swine were affected with the disease in that country in 1890. The infection, quite insignificant in 1886, had been gradually spreading until it reached the enormous figures given above in 1890. During this same year it prevailed in France, Italy, Belgium, Austria-Hungary, Switzerland, Roumania, and Bulgaria.

The losses from this disease in England in the year 1883 were estimated at \$5,000,000. An English practitioner of wide experience states that it is none too high to place the loss upon each animal that becomes infected but that ultimately recovers at \$20, when milch cows or feeding cattle that are nearly finished are under consideration. On store cattle and calves the loss is proportionally less.

Estimating the losses upon the surviving animals from this basis and adding the value of those that die, it will be seen that an outbreak of this disease may quickly result in direct losses of many millions of dollars. In addition to this, a considerable spread of the contagion in this country would entail the entire loss of our export trade in live animals, interruptions of domestic commerce, and quarantines, which would surpass the loss caused by the ravages of the disease.

Unlike most other infectious diseases, foot-and-mouth disease may attack the same animals repeatedly. The immunity or protection conferred is thus only of limited duration. Hence protective inoculation with the virus, in whatever manner it may be practiced, is not only of no use, but decidedly dangerous, as it will introduce the disease. It is, however, not uncommon in European countries to practice inoculation after the disease has appeared in a herd in order to hasten its progress. This is highly recommended by some, since it not only hastens the infection, but the disease is apt to be milder and limited to the mouth. It consists in rubbing with the finger or a piece of cloth a little of the mucus from the mouth of a diseased animal upon the inner surface of the upper lip of those to be inoculated. From 50 to 75 per cent of the inoculated animals take the disease.

As with other communicable diseases, the source and origin of foot-and-mouth disease has given rise to much speculation. The disease had been known in Europe for centuries, but it was not until a com-

CAUSE.

paratively recent date that the erroneous conceptions of its spontaneous origin as a result of climatic and meteorological conditions, exhausting journeys, etc., were abandoned. It is now conceded that foot-and-mouth disease is propagated by a specific virus and that every outbreak starts from some preexisting outbreak.

The causative agent of this disease has not been isolated, although numerous attempts have been made to cultivate and stain it. Experiments have shown that the virus will pass through standard germ-proof filters, thus indicating its minute size and the reason it has not been detected by the staining methods. The contagion may be found in the serum of the vesicles on the mouth, feet, and udder; in the saliva, milk, and various secretions and excretions; also in the blood during the rise of temperature.

A wide distribution of the virus and a rapid infection of a herd is the result. Animals may be infected directly, as by licking, and in calves by sucking, or indirectly by fomites, such as infected manure, hay, utensils, drinking troughs, railway cars, animal markets, barnyards, and pastures. Human beings may carry the virus on their clothing and transmit it on their hands when milking, since the udder is occasionally the seat of the eruption. Milk in a raw state may also transmit the disease to animals fed with it.

The observations made by some veterinarians would lead us to suppose that the virus is quite readily destroyed. It is claimed that stables thoroughly cleaned become safe after drying for a short time. Hence litter of all kinds, such as manure or soiled hay and straw, may remain infective for a longer time because they do not dry out. Other authorities maintain that the virus is quite tenacious and may live in stables even so long as a year. They also state that animals which have passed through the disease may be a source of infection for several months after recovery.

SYMPTOMS.

In three to six days after the exposure of the animal to the infection the disease makes its appearance. It is first indicated by the animal suffering from a chill, quickly followed by an invasion of fever, which may cause the temperature to rise as high as 106° F. Following this in one or two days it will be noticed that small vesicles about the size of hemp seeds or a pea are making their appearance upon the mucous membranes of the mouth at the border and upper surface of the tongue near the tip, the inside of the cheeks, on the gums and the inner surface of the lips, or on the margin of the dental pad. These little blebs contain a yellowish watery fluid and gradually become more extensive as the disease advances. Soon after the erup-

tions have appeared in the mouth of the animal it will be noticed that there is considerable swelling, redness, and tenderness manifest about the feet, at the coronet and between the digits of each foot. Eruptions similar to those within the mouth make their appearance upon these swollen regions of the foot a day or two later, and at this stage it is usual to find that like lesions have made their appearance upon the perineum of the victim. In the case of milch cows, the udder, and more particularly the teats, show the same vesicular eruption, but the latter as the result of milking soon become covered with reddened spots deprived of the superficial layer of skin and may develop deep, obstinate fissures.

As soon as the disease has become well established the patient evinces pain when attempting to eat, in fact the appetite is often so seriously affected that all food is refused and the animal uneasily opens and shuts its mouth with a characteristic smacking sound, while strings of cohesive, ropy saliva hang suspended from the lips. With the advance of the disease the vesicles have widened and extended until they may reach a diameter ranging from that of a dime to that of a silver dollar. These rupture soon after their appearance, sometimes on the first day, more rarely on the second or third day. After they have ruptured the grayish white membrane forming the blister may remain attached for a day or more, or disappear speedily and leave deeply reddened sensitive spots or erosions, both within the mouth and upon the coronet and between the claws of the feet. The same ulceration may be noticed in cases in which the teats of milch cows have become affected, and instances are reported in which sloughing of the tegument immediately around the ulcer upon the udder has occurred. Owing to the tough, fibrous nature of the bovine skin it is exceedingly rare for sloughing to occur upon any part of the body other than those mentioned.

The attack upon the feet of an animal is frequently manifested in all four feet at once, but one or more of the feet may entirely escape and remain unaffected throughout the course of the disease. As the feet become sensitive and sore the animal lies down persistently, and it has been found that bed sores develop with amazing rapidity in all such cases and wholly baffle all attempts at treatment until after the patient has regained its feet.

The disease may attack some of the internal organs before it appears upon any of the external tissues. These cases are very liable to prove quickly fatal. The animal dies from paralysis of the heart due to the formation of poisonous principles within the system, or it may suffocate by reason of the action of these same poisons upon the tissues of the lungs, or it may choke to death as a result of paralysis of the throat.

In cases of serious affection of the udder the erosions will often be found located within the passages of the teats, resulting in a "caked" udder, and the same toxic poisoning which is the cause of death in the apoplectiform types just mentioned may arise from this source. In any event the milk from such cases will be found dangerous for use, causing fatal diarrhea in sucking calves or young pigs and serious illness in human consumers. The milk obtained from cows suffering with foot-and-mouth disease is not readily converted into either butter or cheese, but remains thick, slimy, and inert in spite of churning and attempts at curdling. The ulceration of the interdigital tissue may extend to the ligaments of the fetlock or produce disease of the joint or bone. Pregnant animals may abort. In pigs, sheep, and goats the lesions in the foot are most common, but both forms may be observed or only the mouth lesions.

When the disease has become fully established it will be found that the duration of the attack will vary greatly with different animals. From ten to twenty days are usually required for the recovery of the normal appetite and spirits in mild outbreaks, while the return to a full flow of milk, in the case of milch cows, is seldom witnessed before the arrival of the following season.

In the malignant type of the disease it requires from three months to a year for an animal to recover. The mortality is not great, generally about 1 to 3 per cent, but in severe outbreaks it may reach 5 per cent. It is more fatal in young animals that have been fed on infected milk, and produces death in from 60 to 80 per cent of these cases as a result of gastro-enteritis.

DIAGNOSIS.

The recognition of this affection should not, as a rule, be difficult, especially when the disease is known to be in the vicinity; in fact, the group of symptoms form a clinical picture too decided to be doubted. The combination of high fever, vesicular inflammation of the mouth, and hot, painful, swollen condition of the feet, followed in twenty-four to forty-eight hours by the appearance of numerous small vesicles varying in size from that of a pea to that of a hazelnut on the udder and feet and in the mouth should prevent any serious or long-continued error in the diagnosis. However, in the inoculation of calves we have a certain and final test. In twenty-four to seventy-two hours after inoculation the calves present the characteristic vesicles. Such inoculation should be practiced, however, only by officials who are properly authorized to deal with contagious diseases.

DIFFERENTIAL DIAGNOSIS.

It can be asserted positively that no disease of cattle closely simulates the symptoms of the eruption of aphthous fever on the lining membrane of the mouth. Cowpox or horsepox may be accidentally

transmitted by inoculation. But the eruption in the "pox" goes on to the development of a pustule, while in foot-and-mouth disease the eruption is never more than a vesicle, even though the contained fluid may become turbid.

The inoculation test in the case of cowpox does not respond with fever and eruption for at least ten days, and often longer.

In mycotic stomatitis or inflammation of the lining membrane of the mouth the entire buccal cavity is inflamed and in a few days the croupous membrane forms, peels off, and exposes a raw, bleeding surface, while the thin skin between the toes may also be inflamed. The previous history of the case; the failure of the vesicles, if any appear, to spread extensively; the absence of vesicular eruptions on other portions of the body, notably the udder and teats, and, characteristically, the hoof, together with the absence of infection in the herd and the complete negative character of inoculation of calves, distinguishes between the local disease named and foot-and-mouth disease.

The lesion resulting from ergotism may be differentiated from those of foot-and-mouth disease by the lack of eruptions in the mouth and by the location of the disease at the tips of the ears, end of the tail, or upon the lower part of the legs, usually below the knees or hocks. The lesion of ergotism does not take the form of pustules or blisters, but manifests itself first as a swelling about the ankle, which later may slough and circumscribe the limb, forming a deep crack, extending entirely around the limb and forming a distinct line of demarcation between the healthy skin above and the diseased below. The absence of ulcerous sores on the coronet and between the claws, together with a healthy condition of the membranes of the mouth and the knowledge that the lesion upon the limb in question extends uninterruptedly around it, should point conclusively to a diagnosis of ergotism and to the exclusion of all fears of foot-and-mouth disease.

In foul foot or ground itch of cattle the inflammation of the skin and toes is general and not in certain spots, as in foot-and-mouth disease; the mouth remains unaffected, and the presence of the disease may be traced to filth and poor drainage.

The severer forms of the disease might be confounded with certain general diseases. Where gastro-intestinal symptoms predominate acute gastric catarrh or inflammation of the intestines might be thought of. Involvement of the lungs might lead to a diagnosis of acute congestion of the lungs or pneumonia. The distinction is apparent in these diseases by the lack of vesicular eruption on the mucous membrane or skin, and also by lack of evidences of infection in the herd or neighboring animals.

PREVENTION.

The measures to be adopted to prevent the spread of the affection must take into consideration the highly infectious nature of the

disease, its ease of dissemination, and the liability of the virus to live a saprophytic life for long periods. Great care should therefore be observed in keeping healthy animals unexposed to the contagion. When an outbreak occurs in a community, the owner should make every effort to keep other animals from coming in contact with his diseased cattle. This especially applies to dogs, cats, goats, and poultry, which usually have access to the stables and barnyards and in this way furnish excellent means for disseminating the infectious principle. He should be equally particular in prohibiting any person from coming onto his premises, especially an attendant or owner or other person in any way connected with cattle. Such a herd may be placed under quarantine, with an inspector appointed to keep the premises under constant surveillance.

This method of quarantine alone, while very satisfactory in many instances, is rather tardy in obtaining the desired result. For this reason when the disease breaks out in a country like the United States, where the contagion is likely to spread rapidly by means of infected cars, manure, hay, and other feed, and where the results of its obtaining a firm foothold would be so disastrous, it seems that this method of temporizing is rather tedious, and more radical steps are required in order to suppress and eradicate completely the infection in the quickest and most thorough manner possible.

It would therefore appear better to concentrate the expense incident to the extermination of foot-and-mouth disease by purchasing and slaughtering all affected and exposed cattle after judicious appraisalment. The carcasses of these animals should be totally destroyed, preferably by cremation, or otherwise by burying them in a hole 6 feet deep and covering them with air-slaked lime. The infected stable should be disinfected by thoroughly cleaning it, scrubbing the floor with hot water, brushing down all loose dust from the walls, and tearing off all woodwork which is partly decayed. Then the whole interior of the stable should be covered with a good coat of limewash containing 1 part of a 40 per cent solution of formaldehyde (which is sold by the drug trade under the commercial name of formalin) to 30 parts of the limewash, or 4 ounces of formalin to each gallon of limewash. Another efficient wash for this purpose may be prepared by adding 6 ounces of chlorid of lime to each gallon of limewash. All stable utensils should be thoroughly cleaned and disinfected by the application of a solution containing 4 ounces of formalin to a gallon of water, or 6 ounces of crude carboic acid to each gallon of water. The manure should be burned or spread over ground (other than meadow land) that is to be turned under. No other cattle should be purchased for at least thirty days after the complete disinfection of the premises.

[Cir. 141]

The method of eradicating the outbreak of foot-and-mouth disease in New England in 1902-3 consisted in the rigid quarantine of all infected premises and of the animals upon them, in slaughtering the diseased and exposed animals at the earliest practicable moment, and in thoroughly disinfecting the stables and the contents of the buildings in which they had been sheltered. The progress of this work, the confinement of the disease to four of the New England States, and its complete eradication in a comparatively short time demonstrates in a striking manner the efficacy of slaughtering and the futility of relying upon quarantine alone in stamping out the disease.

Inoculation has been adopted in some countries in order to have the disease spread quickly through the herds, and while this practice has undoubted value where the disease is indigenous, it is not desirable in this country and should not be adopted.

MEDICINAL TREATMENT.

In some mild attacks of foot-and-mouth disease great benefit may be derived from a judicious attempt to relieve the symptoms and thus assist nature in overcoming the disease, but the great danger attached to the presence of an infectious disease in any noninfected locality for twelve to twenty days, while the disease is running its course, must appeal to the sanitarian and prevent indiscriminate medicinal treatment.

However, beneficial results have been obtained by the local application of disinfecting and astringent lotions. A teaspoonful of alum, chlorate of potash, boracic acid, or one-half teaspoonful of the tincture of aloes and myrrh placed in the mouth has proved efficacious. The infected animals may be made to stand from five to ten minutes in a shallow trough containing medicinal agents such as a 1-to-1,000 solution of bichlorid of mercury or a 3 per cent carbolic acid or creolin solution. Where the teats and udder are affected the application of carbolized vaseline, camphor ointment, or borated glycerin has given excellent results. If the symptoms of heart weakness are manifest, give digitalis, camphor, or alcohol, while excessive fever may be reduced with phenacetin.

The complications that may follow the disease are usually the result of contaminating bacteria, and it is therefore desirable to have the animals and their surroundings kept in as cleanly a condition as possible. The cattle should be fed on soft meal or grain and given a plentiful supply of clean water.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., November 14, 1908.

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SOME IMPORTANT FACTORS

IN THE

PRODUCTION OF SANITARY MILK.

BY

ED. H. WEBSTER,

Chief of the Dairy Division.

[Reprinted from the Twenty-fourth Annual Report of the Bureau of Animal Industry (1907).]



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SOME IMPORTANT FACTORS IN THE PRODUCTION OF SANITARY MILK.

By ED. H. WEBSTER,
Chief of the Dairy Division.

INTRODUCTORY.

It is evident that in nature's scheme for the nourishment of the young milk was never intended to see the light of day, and if sucked from a normal, healthy gland it is the perfect food for the offspring. In this natural method of nourishment there is little possibility of contamination from outside sources. As soon as the artificial method of drawing milk is resorted to, however, there enters a whole set of conditions entirely new and different. The milk then comes in contact with the air, the vessel into which it is drawn, and with particles of dirt from many sources.

Milk properly drawn, from healthy cows, in clean surroundings, handled in a sanitary manner, and delivered to the consumer in a comparatively short time, is free from disease-producing organisms and is ideal as a food. The problem of securing clean milk—i. e., milk as near as possible to the condition as it exists in the udder—is the problem of dairy sanitation. To put it in another way, it is the problem of reducing contamination from all outside sources to the least possible factor. Few cows, however, are properly milked; many herds are not free from disease; many farmers understand but little of sanitary methods, and but a small proportion of the milk coming into any city of considerable size can be delivered to the consumer soon after milking.

HOW MILK IS CONTAMINATED.

If the mere presence of solid particles of dirt so frequently found in the milk were the only damage wrought, the question would resolve itself into the simple operation of straining the milk or passing it through a clarifier. The presence of solid dirt is, however, an indication of much more serious conditions. Bacteriology teaches that every particle of dirt, whether it seems to the eye a source of contamination or not, carries with it great numbers of bacteria, and that milk at ordinary temperatures, 65° to 100° F., is an excellent medium for their growth, and most of the changes that take place in milk can be traced directly to such action. Neither straining nor clarifying will remove the bacteria from the milk; hence the necessity of keeping the dirt out, not straining it out.

From the act of milking to the final consumption of the milk the possibilities of contamination are many and varied in character. Everything that comes in direct contact with the milk may be a source of trouble, and many things may act indirectly and seriously affect the results desired.

Contamination usually begins with the act of milking. If the udder and flanks of the cow are covered with the dirt of the yard or stable the process of milking will dislodge a greater or less portion of this filth, causing it to fall into the pail. The amount of filth that may be on a cow will depend very much on the conditions of the stable yard and the floor, gutter, and bedding in the stables. (See figs. 21, 23, 25, and 27.)

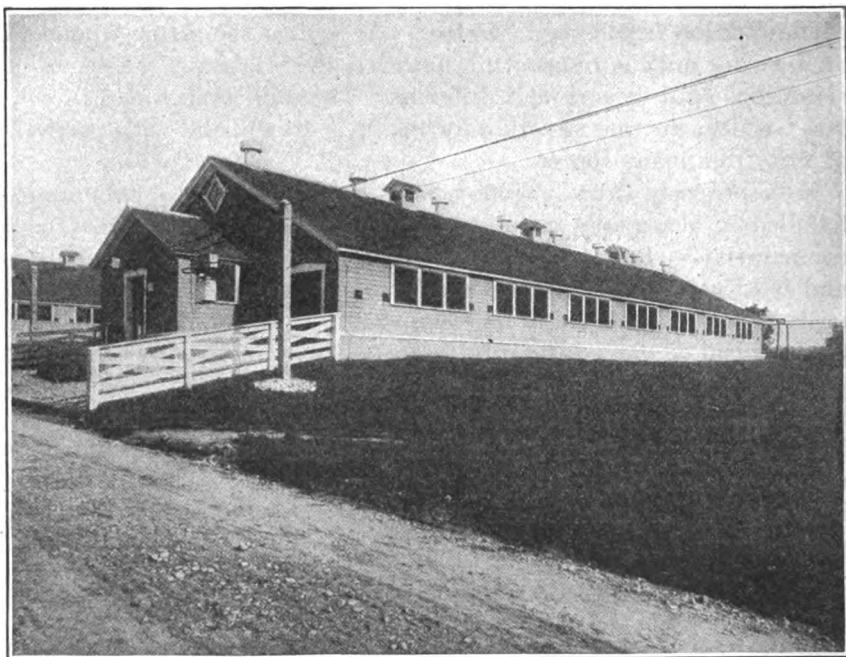


FIG. 20.—Exterior of a model dairy barn.

As to the amount of filth that will get into the milk and its effect on the product, reports from the Illinois Experiment Station and the Storrs (Conn.) Experiment Station are here quoted:

The average weight of dirt which falls from muddy udders during milking is 90 times as great as that which falls from the same udders after washing, and when udders are slightly soiled it is 32 times as great.^a

Wiping the flank and udder of the cow with a damp cloth just before milking is a very efficient method for reducing the number of bacteria which falls into the milk pail.^b

^a Illinois Experiment Station, Bulletin 84. .

^b Storrs Experiment Station, Bulletin 42.

An average of 13 experiments at the Storrs station showed the following results:

Bacteria in milk from unwiped udders per cubic centimeter.....	7,058
Bacteria in milk from wiped udders per cubic centimeter.....	716
Decrease due to wiping.....	6,342

The milker may not be cleanly in person or dress; he may have that most filthy of habits, milking with wet hands. The hands are usually wet by milking a few streams over them, and kept wet by repeating the operation from time to time. The filth on the udder will ooze out under and through the fingers and drip into the pail. This condition is frequently met in inspection work.

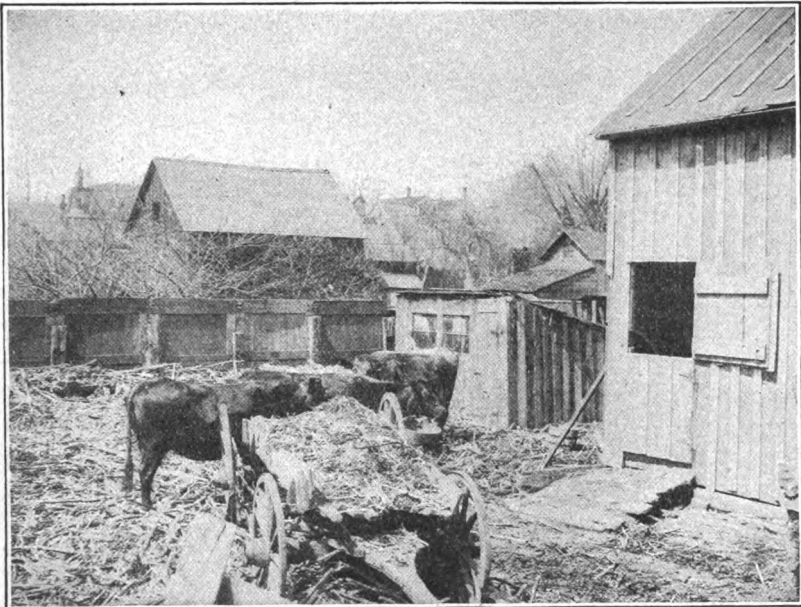


FIG. 21.—Insanitary barnyard. Manure and filth evident everywhere. It is impossible to keep cows clean in such surroundings.

Milkers too often wear clothing that has done duty for every other work about the farm. Such clothing may contain dirt from the hog pen, the chicken coop, the horse barn, or the swill barrel, and is entirely unfit to be worn during milking. A clean white milking suit has a twofold effect. It will not of itself contaminate the milk, and if the milker is required to keep such a suit clean he must of necessity keep everything with which he comes in contact clean.

The difference in results between different milkers working under the same conditions is strikingly illustrated by Stocking.^a The average of 19 tests in which 2 milkers who had had no training in

^a Storrs Experiment Station, Bulletin 42.

dairy sanitation and 1 milker who was a graduate of the Connecticut Agricultural College showed 17,105 bacteria per cubic centimeter for the untrained men and 2,455 for the trained man. The only difference between the men was the knowledge of what constituted contamination, gained by the college graduate, who was a student of bacteriology.

EDUCATION AND REGULATIONS.

This example well illustrates the difficulty encountered in securing clean milk by means of police regulations only. Education must go first, and the police authority should be used only in cases where the

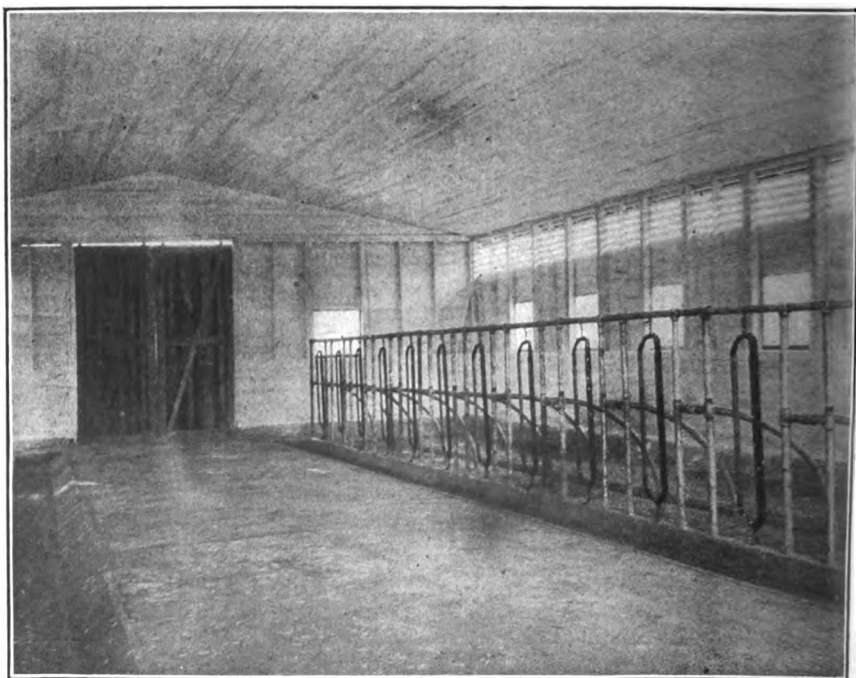


FIG. 22.—Interior of an inexpensive but good dairy stable. Well lighted and ventilated and easily kept clean.

dairyman persists in willfully disregarding sanitation when he knows better. But little improvement will come through regulations requiring clean cows, clean milkers, and clean methods of milking and of handling the milk unless the dairyman understands the object of such regulations and the effect they will have on his work. The officers in charge of inspection must be teachers first and policemen only when they find that the dairyman will not live up to the instructions given him and his knowledge of what is right.

Rules and regulations intended to correct evils often fail in their purpose because of injudicious administration on the part of health

officers, but much oftener from the fact that a man who is by nature filthy in his habits can not be legislated into cleanliness. If he is willing to drink at his own table milk which contains only a little cow dung, he takes it as an infringement of his personal rights and liberties if the authorities attempt to compel him to keep such material out of the milk that goes to his neighbors.

The illustrations accompanying this article are all made from photographs taken in the course of inspection work, and have been selected with a view to presenting a contrast between desirable and undesirable conditions of milk production. They show that more rigid inspection is absolutely necessary, that competent inspectors

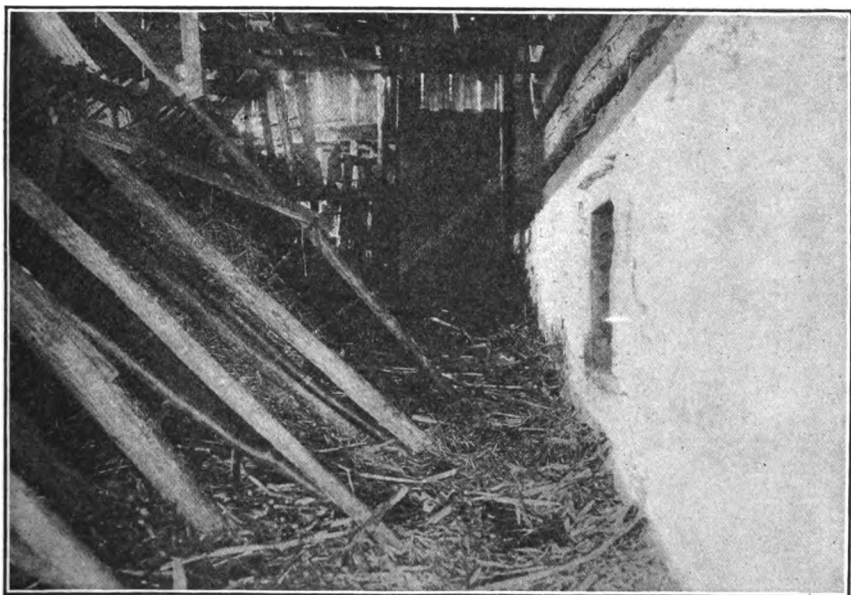


FIG. 23.—Interior of an insanitary dairy stable. It is impossible to avoid contaminating milk drawn in such a place.

must be employed to instruct, and, where instruction is not sufficient, to demand a better state of affairs. Laws and ordinances must be strengthened and the public educated to demand clean milk from clean dairies.

One important item that must be borne in mind is the fact that to change these conditions must cause some expense to the producer, and the consumer must expect to foot the bills. A prominent veterinarian in Kansas City, Mo., recently said in regard to the milk supply of that city that the prevailing price of milk was based on a system which required only that the solid and coarsest dirt be strained out. If the consumer wanted milk that had been kept free from such contamination he would have to pay for the added cost of production.

UTENSILS, EQUIPMENT, HOUSES, ETC.

The milk pail should be made so as to reduce to a minimum the amount of dirt and hair that can get into it during the operation of milking. The form with a wide top is in most common use and is most objectionable. The narrow top, in some form or other, will undoubtedly, in time, replace the wide top. Pails and all other vessels designed to hold milk should be seamless if possible, and where seams must occur, they should be flushed full and smooth with solder. There should be no place either inside or out that can not be reached with the brush in washing. Heavily tinned utensils are recognized

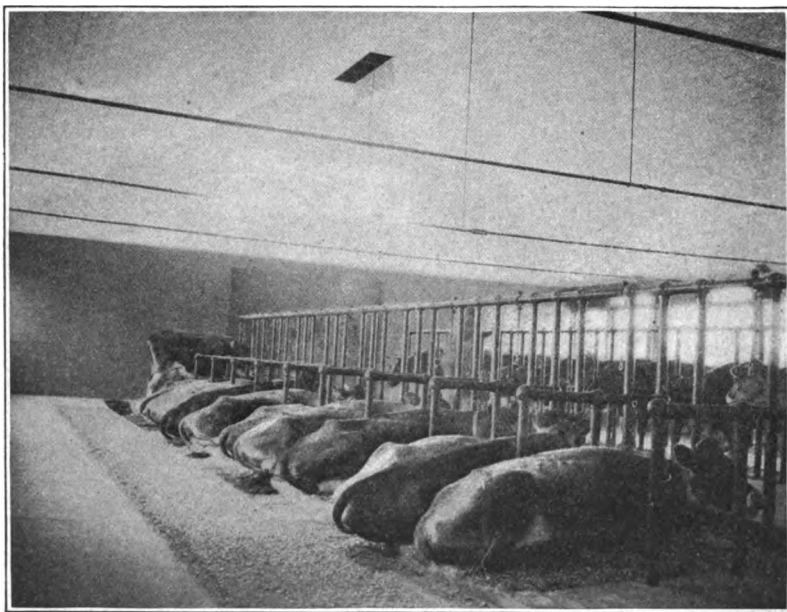


FIG. 24.—Clean cows in clean, comfortable, light, and airy stalls.

as the best for milk purposes. Wood, galvanized iron, or any material that is rough or porous is unfit for milk vessels.

No important part of the dairy work is so often neglected as the cleaning of the milk utensils. It can not be too strongly emphasized that dairy utensils must, after the milk is washed from the surface with warm water, be scalded with boiling water or steam. Nothing short of this will insure clean milk.

Milk after being drawn should be removed at once from the barn to a clean place for cooling. The milk house should be provided with an ample supply of hot and cold water, the necessary cooler, and other apparatus and supplies for handling milk. The surroundings

of the milk house should be neat and clean and the air at all times free from objectionable odors. Cement finish on the interior is better than wood, but success is due to the scrupulous cleanliness observed, and under these conditions the wood is unobjectionable.

CARING FOR THE MILK.

The bacterial content of milk at any time depends upon the age of the milk, the initial number of bacteria introduced through the processes of milking and handling, and the temperature at which the milk has been kept. Consequently clean milk, quick cooling, and short

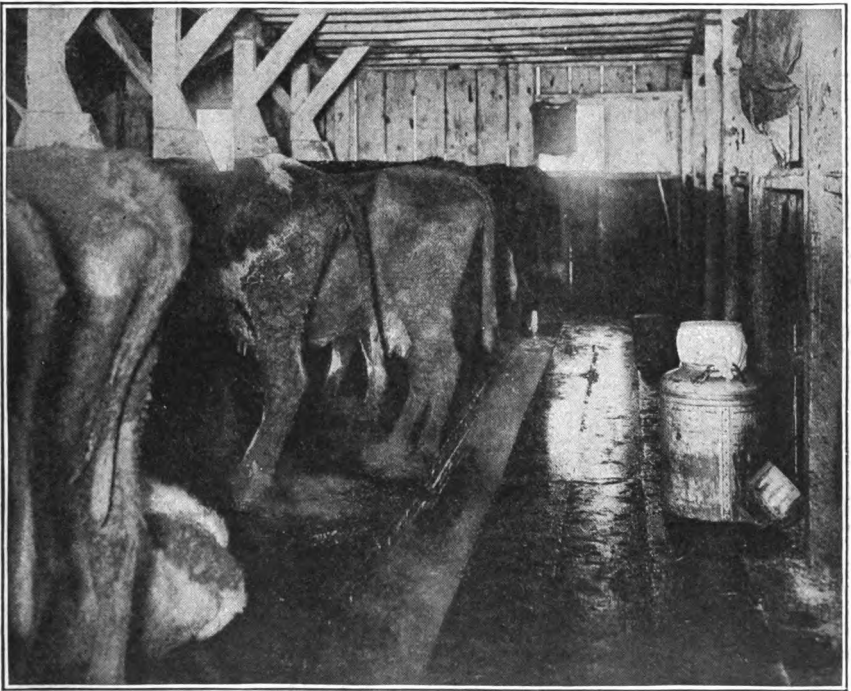


FIG. 25.—Cows coated with filth in a dirty stable. Much of this filth gets into the milk.

time between milking and consumption are very important factors in securing pure milk. A careful survey of the milk supply of a number of cities indicates that not enough attention is paid to these factors by either producers, distributors, or inspection authorities. Milk should be cooled immediately and kept cool until it is consumed. Between the farm and the consumer often several agencies are employed. Hauling to the depot, holding at the shipping point, transportation on the cars, and the handling in the city milk plants are steps in the process of supplying a city that need intelligent and conscientious care

All that has been said about cleanliness, surroundings, and care in handling milk on the farm applies to the city plant where milk is received and distributed to the consumer. So far as insanitary surroundings are concerned, it is usually the smaller dealers who are the greatest offenders. They usually lack facilities for scalding or sterilizing bottles and utensils, and depend too much on the help of the family, often children, to wash bottles and utensils and do much of the work of the dairy.

DAIRY INSPECTION.

For an efficient system of dairy inspection it is recommended that there be an inspector for approximately every 100 dairy farms.



FIG. 26.—Milking cows under clean conditions.

These inspectors should be skilled in all subjects pertaining to the production and distribution of milk. Half of the inspectors should be skilled veterinarians, and the other half should have had training in a good dairy school or have had experience which would be the equivalent of such training.

Inspectors should devote their entire time to the work of inspection and should not be allowed to do outside work that in any way relates

to the business of inspection. There should be a chief inspector to supervise the work, and he should be responsible to the health officer. The health officer, or board of health, should have full power to make rules and regulations and enforce the same so as to safeguard the health of the community from a contaminated milk supply through either carelessness, ignorance, or malicious intent.

THE SCORE-CARD SYSTEM.

For the past two years the Dairy Division of the Bureau of Animal Industry has been making a thorough investigation of the city milk

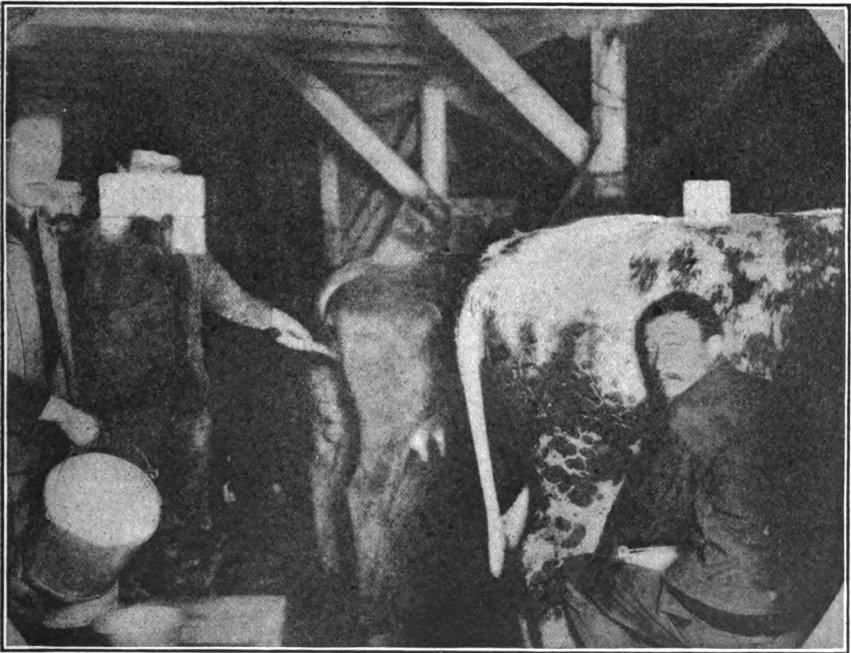


FIG. 27.—Milking cows under filthy conditions with unavoidable contamination of milk.

supply of a large number of cities of the country with a view to establishing a system of inspection and reporting on dairies that would be complete, comprehensive, and meet the needs of the public in the improvement of the milk supply. Dr. W. C. Woodward, health officer of the District of Columbia, was the first to introduce a score-card system of reporting on dairies. A little later Prof. R. A. Pearson, of Cornell University, introduced a card for the same purpose. The cards had many good features, and if they had been generally adopted would have done much to improve the dairy conditions of the country.

The Department of Agriculture took up the work with the hope of extending the use of the score card and thereby promoting more thorough inspection. After three years' work, scoring several thousand dairies in all parts of the country, a score card has been adopted in a more or less modified form and has been introduced and used in about 60 of the larger cities of the country and in many smaller ones. The following is the form of the present card for farm dairies:

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SANITARY INSPECTION OF DAIRIES.

DAIRY SCORE CARD.

Owner or lessee of farm.....
Town..... State.....
Total number of cows..... Number milking.....
Quarts of milk produced daily..... Product is
sold at wholesale retail. Name and address of dealer to whom shipped
.....
Permit No. Date of inspection....., 190...
Remarks
.....
.....
(Signed)

Inspector.

[Back of card.]

DETAILED SCORE.

Equipment.	Score.		Methods.	Score.	
	Perfect.	Allowed.		Perfect.	Allowed.
COWS.			COWS.		
Condition.....	4		Cleanliness.....	10	
Health (outward appearance).....	6				
Comfort.....	4		STABLE.		
Bedding.....	2		Cleanliness.....	12	
Temperature of stable.....	1		Floor.....	4	
Protected yard.....	1		Walls.....	2	
Cubic feet of space per cow:			Ceiling.....	2	
Over 300, 2; over 400, 4; 500			Ledges.....	1	
to 1,000, 6.....	6		Mangers and partitions.....	1	
Feed.....	4		Windows.....	1	
Water.....	8		No other animals in stable.....	1	
Clean.....	6				
Fresh.....	2		Stable air.....	4	
STABLE.			Removal of manure.....	4	
Location.....	6		To field or proper pit.....	4	
Well drained.....	3		30 feet from stable.....	2	
Free from contaminating surroundings.....	3		Cleanliness of stable yard.....	2	
Construction.....	10		MILK ROOM.		
Tight, sound floor.....	3		Cleanliness.....	6	
Gutter.....	1		Care and cleanliness of utensils.....	10	
Stall, stanchion, tie.....	1		Inverted in pure air.....	2	
Low-down manger.....	1		Clean (superficially).....	4	
Smooth, tight walls.....	1		Sterilized.....	4	
Smooth, tight ceiling.....	2		MILKING.		
Box stall.....	1		Cleanliness.....	14	
Light: 1 sq. ft. glass per cow; 2;			Clean, dry hands.....	4	
2 sq. ft., 4; 3 sq. ft., 6; 4 sq.			Udders washed and dried.....	10	
ft., 8; even distribution, 2.....	10		Cleaned with moist cloth.....	8	
Ventilation: Sliding windows, 2;			Cleaned with dry cloth.....	4	
hinged at bottom, 4; King system			CARE OF MILK.		
or muslin curtain, 8.....	8		Cooling.....	20	
Stable yard (drainage).....	2		Removed from stable immediately		
MILK ROOM.			after milking each cow and		
Location.....	6		promptly cooled.....	10	
Convenience.....	2		Cooled to 50° F. or below 10		
Free from contaminating surroundings.....	4		51° to 55° F.....	8	
Construction.....	4		56° to 60° F.....	6	
Floor.....	1.5		Storing.....	8	
Walls and ceilings.....	1		Below 50° F.....	8	
Light.....	.5		51° to 55° F.....	6	
Ventilation.....	.5		56° to 60° F.....	4	
Screens.....	.5		Transportation.....	10	
Arrangement.....	2		Iced in summer.....	10	
Equipment.....	6		Jacket or wet blanket in summer.....	8	
Hot water or steam.....	2		Dry blanket.....	4	
Cooler.....	2		Covered wagon.....	2	
Narrow-top milk pail.....	1				
Other utensils.....	1				
Water supply for utensils.....	10				
Clean.....	6				
Convenient.....	2				
Abundant.....	2				
Milking suits.....	4				
Total.....	100		Total.....	100	

• Score of methods.....multiplied by 2 =

Score of equipment.....multiplied by 1 =

Total.....divided by 3=.....final score.

NOTE.—Deductions may be made for exceptionally bad conditions.

NOTE.—If the herd has not been tuberculin tested within a year, the limit for the score will be 80.

The use of these cards enables a more perfect study of conditions to be made in any city. The results so reported are comparable and can be analyzed with greater ease and accuracy.

Perhaps not the least valuable part of the score-card system is the demand it makes for better and more competent inspectors. It has usually resulted in the dissatisfaction of inspectors with their previous work. The study of the premises in detail with the view to fixing the exact value of conditions requires better and more conscientious work. Wherever the system has failed—and but one or two such instances are known—this has been because the inspector did not relish the comparison of the results with his previous work.

A striking example of the improvement brought about by the score-card inspection system is given in the work of the Richmond, Va., board of health, as follows:

Table showing percentage of dairy farms in various classes during the first twelve months of dairy inspection at Richmond, Va., May 1, 1907, to May 1, 1908.

Class.	Percentage of all dairies inspected for the month which fell in each class.											
	1907.								1908.			
	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Scoring below 30.....	13.8	26.5	3.9	4.0	.....	.....	.....	.....	.....	.....	.....	.....
Scoring between 30 and 40..	30.8	42.9	21.0	10.7	.....	.....	.....	.....	.....	.....	.....	.....
Scoring between 40 and 50..	26.2	22.4	38.2	29.4	40.0	23.7	14.8	15.8	2.8	.....	.....	.....
Scoring between 50 and 60..	13.8	8.2	22.4	33.3	45.0	35.6	45.9	36.8	11.3	13.6	6.8	5.7
Scoring between 60 and 70..	10.8	.....	13.2	22.6	12.5	33.9	29.5	23.6	35.2	44.1	39.8	34.3
Scoring between 70 and 80..	4.6	.....	1.3	.....	2.5	6.8	8.2	18.4	31.0	25.4	34.2	42.9
Scoring between 80 and 90..	.....	.....	.....	.....	.....	.....	1.6	5.4	19.7	16.9	19.2	17.1
Average of all scores for month.....	41.5	36.4	47.5	50.5	51.4	57.0	58.4	60.5	70.4	69.6	71.5	72.0

The average increase in scores, as shown by the foregoing table, is 30.5 points, or 71 per cent.

FEATURES OF INSPECTION.

The routine of inspection should include (1) health of attendants, (2) health of the herd, (3) purity of the water supply, (4) methods of the dairyman, (5) facilities for producing pure milk, and (6) handling and transportation from farm to city.

These will be discussed briefly in the order given.

HEALTH OF ATTENDANTS.

Dr. John W. Trask, passed assistant surgeon in the United States Public Health and Marine-Hospital Service, says:^a

During the last fifty years there has been piling up a mass of evidence which would seem to show that milk may receive from man the specific organisms of

^a Bulletin 41, Hygienic Laboratory, United States Public Health and Marine-Hospital Service.

certain infectious diseases, and that these organisms may retain their virulence for some time and produce the disease in susceptible individuals drinking raw milk.

He lists over 500 epidemics which have been traced directly to milk as the medium through which they were spread. The distribution of milk from sources of such contamination is now absolutely prohibited by law in most cities, and yet in what city is the inspection so complete as to insure beyond any question of doubt that every milk producer obeys the law?

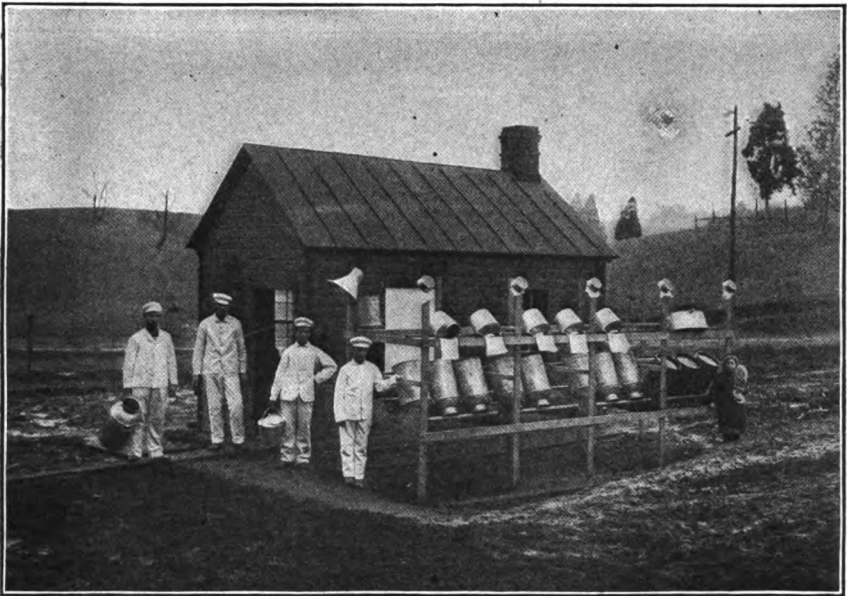


FIG. 28.—An inexpensive but clean dairy house. Milkers in clean white suits; pails and cans handled in a sanitary manner.

HEALTH OF THE HERD.

The health authorities and the consuming public are just beginning to awaken to the dangers of contamination of the milk supply through diseased cattle. It is unfortunate that the desire for the immediate dollar is in many dairymen greater than their desire to produce and distribute a pure and wholesome milk, though such milk will certainly in the end bring a greater profit. They attempt to hide any fact of sickness in their herds, at the expense of the health of the public. Dr. John R. Mohler, of the Bureau of Animal Industry, in the following recommendations to the Commissioners of the District of Columbia, points out what should be done in this connection:

Milk from cattle showing udder infection or anthrax, rabies, gastro-enteritis, septic conditions, or clinical symptoms of tuberculosis, shall not be utilized as human food, even though the milk be pasteurized.

All milk produced on dairy farms shall come from either tuberculin-tested cattle, which shall be retested at least once a year, or be subjected to pasteurization under the supervision of the health department in case the herd is not tuberculin tested.

PURITY OF WATER SUPPLY.

Even greater than the lack of interest in the health of the cows has been the lack of proper appreciation of the part that a polluted water supply on dairy farms may play in the health of the community. Yet in the great majority of cases trouble of this kind can be very readily overcome. As a result of a survey of 290 dairy

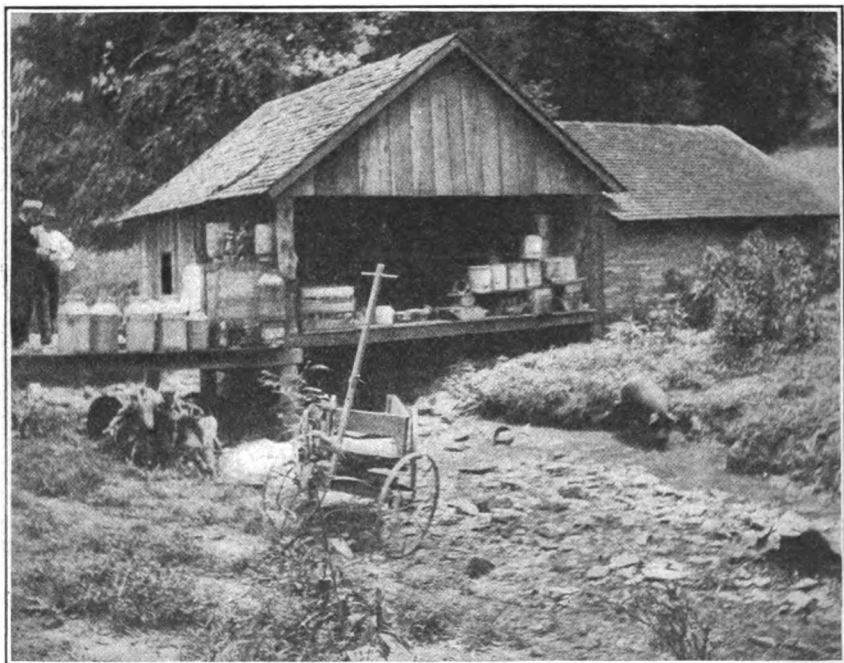


FIG. 29.—An undesirable dairy house. Cans exposed to contamination.

farms in Maryland and Virginia by the Bureau of Animal Industry, Dr. B. M. Bolton sums up this question as follows:

The results seem to show that there are comparatively few water supplies which are free from sanitary objections; but in spite of this fact it is nevertheless probable that in many cases the faults can be rectified. In fact, the faults have already been corrected in some cases where they were pointed out to the owners of the dairies. It would seem advisable in some cases to close up the source of supply, but in most cases all that would be necessary is to point out to the dairymen the sources of pollution and to give them instruction in regard to their avoidance.

To follow out these suggestions means the employment of inspectors competent to pass on the conditions of the water supply. There are too many inspectors employed who can not intelligently do this.

METHODS OF DAIRYMEN.

The weakest point in the inspection system as ordinarily practiced is the inability of the inspector in most cases to be present at milking time. A dairyman's methods should be given at least twice as much weight as the ordinary facilities and utensils with which he works, and the methods to be criticised can be seen at their best or their worst only while the operation of milking is going on. It is the practice of the Dairy Division to score methods separately from equipment, and invariably the score is lower if the inspector sees the milking done than if he has to fill out this part of the card by questioning the owner or his helpers.

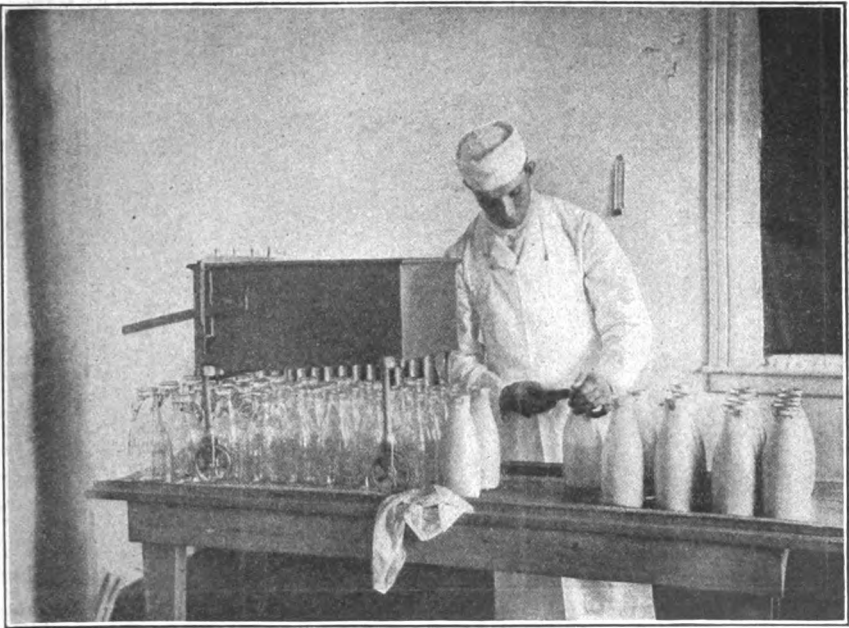


FIG. 30.—A tidy bottling room.

If a man has an inborn capacity or instinct to be clean, a little instruction will enable him to do satisfactory work; but if he is lacking in this quality it is very difficult to change his methods by any amount of instruction or police regulation. The contamination that enters milk because of this lack of the sense of common cleanliness is most serious. This disposition toward uncleanness is responsible for such practices as milking with filthy clothing and hands, filthy udders and flanks, wetting the hands with milk during milking, straining and aerating the milk in the stable, storing and shipping milk in cans that have not been properly washed and ster-

ilized, and many little practices which seem very small and of little importance in themselves, but add, each, their quota to the contamination of milk.

FACILITIES FOR PRODUCING PURE MILK.

The tools with which a man works can only to certain extent determine the fineness of his results. Good results are often obtained with poor tools. Yet the same results might be obtained much more readily if the tools were of the proper kind and fitted for the work.

Barns, stalls, floors, utensils, milk houses, conveniences in conveying and heating water, and all other accessories of the dairy may be

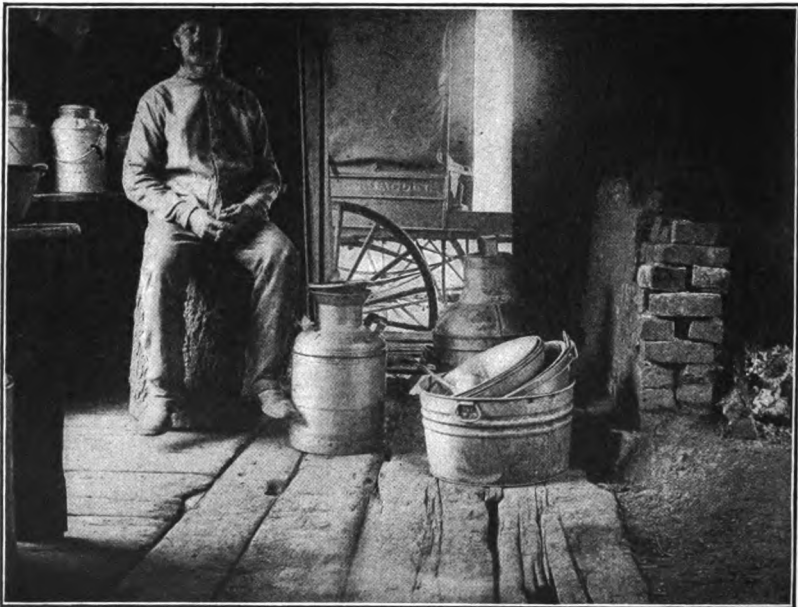


FIG. 31.—A bad place for handling milk.

so constructed and arranged that they require a great amount of labor to produce the desired results, or they may all be so contrived that the labor is easy and the results much more certain. While the mere matter of convenience is one mainly for the dairyman, the authorities should at least require adequate and sanitary equipment and facilities for the production of wholesome milk.

HANDLING AND TRANSPORTING MILK FROM FARM TO CITY.

The same element of doubt as to whether any inspection system can insure perfect work exists here as in the other processes under consideration, though perhaps to a lesser degree; yet there is the pos-

sibility that the milk will be exposed to unfavorable temperatures, delayed in transit, handled carelessly by employees, and delivered in a condition that renders it unfit for consumption as raw milk. These matters should, of course, be guarded against so far as possible by inspection.

THE CLASSIFICATION OF MILK.

It may be impossible for a farmer to meet the ideal conditions. Shall he, then, be compelled to discontinue his dairy? A city can not do without milk, and too rigid requirements of the ideal might easily cause a milk famine.

There are farmers who have the knowledge and the business ability to produce an article so superior that it may be sold as certified milk. Others are also careful in their work, and are so situated that they can produce a high class of milk free from any suspicion of disease organisms, but can not afford the expense attached to the production of certified milk. Each of these classes finds patrons willing to pay the extra cost of such production. As the consuming public becomes more enlightened on the subject, the demand for such milk will increase, as it should.

These classes of milk, however, are but a fraction of 1 per cent of the total milk demanded by a city. The vast proportion of producers are so situated, because of natural environment, personal handicap, or distance that they can not produce a milk which will meet the requirements of an ideal standard. To cut them off would deprive the city almost wholly of milk. This is the condition; what is the remedy? Dr. A. D. Melvin, Chief of the Bureau of Animal Industry, has proposed a system of classifying milk as follows: (1) Certified milk, (2) inspected milk, (3) pasteurized milk. Under this plan all milk of doubtful quality and not meeting the requirements of the first two classes would be rendered measurably safe by pasteurization under official supervision, and no milk not coming within one of the three classes would be allowed to be sold.^a

PASTEURIZATION.

Let it be clearly understood that pasteurization is not recommended as a cure for all the ills of the milk business. No amount of pasteurization will make bad milk good. By destroying disease germs, however, pasteurization will render practically safe milk which would otherwise be dangerous to health; but the quality of the milk, as such, is not improved; rather the reverse is true.

^a The classification of milk is treated in a separate article by Doctor Melvin on page 179 of this volume.

Even with an efficient inspection system, as outlined above, it will not be possible for some time to obtain a sufficient supply of wholesome raw milk, and for this reason pasteurization is recommended as a temporary makeshift for dealing with milk of doubtful quality.

Pasteurization will not take the place of a careful and adequate inspection system. Such inspection system should eventually obviate the necessity for pasteurization, but this can not be accomplished until the consumer is willing to pay the increased cost of pure milk, nor until the producer works on a higher plane than the average do at present.

Issued January 28, 1909.

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A. D. MELVIN, CHIEF OF BUREAU.



MILK AND ITS PRODUCTS AS CARRIERS OF TUBERCULOSIS INFECTION.

BY

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Superintendent of Experiment Station.

[Reprinted from the Twenty-fourth Annual Report of the Bureau of Animal Industry (1907).]



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TUBERCULOSIS OF HOGS: ITS CAUSE AND SUPPRESSION.

BY JOHN R. MOHLER, A. M., V. M. D.,
Chief of the Pathological Division,

AND

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INTRODUCTION.

Tuberculosis in the human family has been lessening materially during the past fifteen years, but reports from the various meat-packing centers of the country fail to show the same encouraging condition regarding tuberculosis in hogs during the same space of time. It must be admitted that reports have come from several localities during the past four years showing a decrease in the number of tuberculous swine sent to market, but a review of the collective records of the country at large shows an increase rather than a decrease in the number of swine affected. Indeed, there is probably no disease of hogs, not even excepting hog cholera, which is causing heavier losses to the hog raiser than tuberculosis, and it is also the cause of great loss to the packers and of much anxiety to the veterinary inspector of meats. Until recent years tuberculosis had been looked upon as of uncommon occurrence, and only of importance from a meat-inspection standpoint; but to-day it must be considered as a general veterinary problem, theoretically easy of solution, which should receive the careful attention of all sanitarians.

The swine of this country January 1, 1908, according to estimates of the Bureau of Statistics of the Department of Agriculture, numbered 56,084,000, and their value at that time was \$339,030,000. From these figures one may partially realize the serious menace to the hog-raising industry which is offered by a disease which affects almost 1.5 per cent of all hogs slaughtered at the abattoirs of this country which have Federal inspection. Reports from European abattoirs show that tuberculosis is far more widespread among their hogs than among ours, some of the returns showing as high as 5.5 to 7.5 per cent. It is to be hoped that the spread of the disease in this country may be checked, and that concerted action by the stock owners and veterinarians may lead to the complete eradication of this costly affection.

The small amount of money required to begin hog raising and the quick returns on the capital invested make this industry an attractive one to the small farmer. The hog will make a pound of gain on less feed than most live stock, and will profitably utilize waste food products of every variety if properly prepared for him. As tuberculosis in this species is chiefly acquired by ingestion, the significance of the latter statement is obvious.

Tuberculosis of hogs is closely associated with the same malady in cattle. The reason for this is apparent when one considers the close relations of these two species of domestic animals upon nearly every farm. The Bureau of Animal Industry is at present endeavoring to locate infected farms, or at least infected localities, and to ascertain the direct cause of the spread of the disease in these districts. Owing to the number of hands through which hogs go before reaching the abattoirs this is not an easy proposition, but it can be and is being accomplished. Already through cooperation with the State authorities a large number of infected farms have been definitely located. The conditions on these farms have been investigated, the source of the disease determined, and methods for its suppression recommended. In Wisconsin the Bureau and State officials have been working with these ends in view. When hogs have been found to be tuberculous and the farm from which they came has been located, the State veterinarian is notified, and he is empowered by law to quarantine any farm when he suspects the presence of a contagious disease thereon. He then applies the tuberculin test to the cattle on the farm and otherwise looks for the source of infection. This frequently results in finding the cattle tuberculous. Similar cooperation has recently been taken up with Nebraska, Iowa, and Minnesota, and the results are equally encouraging.

This cooperation with the State is of great value, and the results would be of greater magnitude if State legislation could be secured compelling the tagging of all hogs going to slaughter, whereby these animals if found tuberculous could be immediately traced to their point of origin and the source of infection removed. It is evident that the suppression of hog tuberculosis would save the country millions of dollars annually, and when it is realized that there are vast numbers of tuberculous hogs killed in abattoirs having no inspection of any kind, it can be seen that the danger to human life from this source would at the same time be removed.

PREVALENCE OF THE DISEASE.

The prevalence of tuberculosis among swine must be judged from abattoir statistics entirely. Thus it has been noted from the records kept by the Bureau of Animal Industry that some sections of the country contribute a far greater proportion of diseased animals than

others. Hogs from Arkansas, Oklahoma, and Texas are remarkably free from this disease, due probably to the method of caring for them, or rather the lack of caring for them. They are not hampered in feed lots as those are in the sections where the disease is mostly found, but are allowed to roam over large areas of pasture and to shift for themselves, and when they are found affected the majority of them show very slight lesions. Furthermore, no prolonged feeding is practiced in narrow bounds as in the corn belt. Lastly, there are relatively few dairies in these sections, and likewise few tuberculous cattle. On the other hand, the hogs are carried from birth to maturity on some form of pasture, as alfalfa, oats, corn, cowpeas, sorghum, rape, and peanuts all the year round. The hogs of the forest region of Hungary which are pasture fed are likewise rarely tuberculous, according to Hertwig, and there can be no doubt that swine fed on entirely vegetable food, as corn and roughage, are proportionately less affected than those fed on dairy products or behind diseased cattle.

A great many hogs in Texas are raised on alfalfa supplemented with corn, and the result is clearly shown in the Bureau statistics which indicate that from January 1 to June 30, 1907, only one-tenth of 1 per cent of over 325,000 hogs slaughtered at Fort Worth showed tuberculous lesions, while only 51, or 0.016 per cent, were condemned as unfit for food. In striking contrast to this may be given the percentages for the same period of three cities in one of the leading dairy States, which show 3.1 per cent, 3.4 per cent, and 6.4 per cent, respectively, of the hogs slaughtered to be affected with tuberculosis. There are a large number of cooperative creameries in the territory contiguous to the three cities alluded to, and the raw skimmed milk is taken home by the patrons for their hogs. Samples of separator slime from the two creameries in the town showing the largest number of tuberculous hogs were injected into guinea pigs and in one instance virulent tubercle bacilli were recovered.

The hog buyers for packing houses are from bitter experience gradually becoming familiar with these conditions and are avoiding certain sections of certain States, and there are at least two eastern packers who will not under any conditions kill hogs from one of the badly infected States. In other localities the packers are beginning to take self-protective measures so as to have the feeder of diseased hogs bear the burden, and many of the smaller establishments in the Central West are buying hogs subject to post-mortem inspection. This attack on the farmer's purse will probably have more beneficial results in making him fully alive to the seriousness of the situation than any other procedure.

In an endeavor to trace the origin of the infection of tuberculous hogs that were arriving at one of the packing plants of Iowa, Rogers of

the Bureau of Animal Industry for some time carried on an experiment which consisted in tagging the hogs that were hauled to market at that place in wagons, before they were removed from the farmers' wagons, and later using these tags as means of identification in case tuberculosis was found to exist in any of the hogs at the time of slaughter. In this manner 3,420 hogs were tagged, and on tracing them to their final disposal it was learned that all of the tuberculous live stock brought to that market came from a few farms—less than 6 per cent of the total, while the remaining 94 per cent of the farms were free from the disease. This proportion of noninfected farms should give great encouragement to any efforts that may be made to eradicate the disease from the State. It was further noted that the successive shipments of hogs marketed by certain farmers always contained tuberculous animals, and in at least two instances the entire consignments were condemned for tuberculosis at the time of slaughter.

PREVALENCE OF TUBERCULOSIS IN FOREIGN COUNTRIES.

Statistics of the sanitary inspection of the Federal slaughter-houses in the Argentine Republic show that the percentage of tuberculous swine is greater than that of tuberculous cattle. This fact is also true in this country, although the contrary is shown in the greater part of the European countries.

In the abattoirs of Buenos Aires the percentage of tuberculous swine for several years past was as follows:

Year.	Per cent.	Year.	Per cent.
1898.....	6.50	1903.....	10.86
1899.....	6.50	1904.....	10.23
1900.....	8.90	1905 to November.....	8.98

In the abattoirs of Liniers at the above city the relation of the two forms of tuberculosis in swine is represented by the following figures:

Proportion of generalized and localized tuberculosis of hogs found at abattoirs of Liniers, Buenos Aires.

Year.	Hogs slaughtered.	Affected with generalized tuberculosis.		Affected with localized tuberculosis.	
	Number.	Number.	Per cent.	Number.	Per cent.
1898.....	36,128	1,160	3.21	1,200	3.32
1899.....	33,066	1,161	3.51	1,273	3.85
1900.....	37,824	967	2.58	2,420	6.40
1903.....	43,531	475	1.09	4,255	9.77
1904.....	41,577	375	.90	8,881	9.33
1905.....	48,077	630	1.31	3,689	7.67

It is seen that there is a striking difference in the relative percentages of the two forms of tuberculosis in the later years as compared with the earlier ones. In the first two years the proportion of generalized tuberculosis is practically the same as the localized, whereas in the later years the generalized has decreased considerably, while the localized has increased to an even greater degree.

From the report of the operations of the veterinary sanitary service of Paris it seems that the appearance of tuberculosis among the hogs that are sent to the abattoirs of that city for slaughter is comparatively rare. Although the statistics which are preserved may not give exact data as to the frequency of tuberculosis among the hogs of that region, they are still accurate enough to show that the disease does not cause any serious losses to the swine breeders of France. The French explain this slight infection by stating that the heaviest losses always occur in countries in which dairy interests have become largely developed.

Deetz finds that tuberculosis exists among the hogs of Germany in differing degrees in the several regions. It is more prevalent in the northern than in the southern part of the country. He has prepared tables showing the number of tuberculous swine condemned at the various abattoirs and for purposes of comparison has included the numbers of tuberculous cattle which have been found at the same abattoirs. These tables show that tuberculosis, both of swine and cattle, is increasing. For instance, during 1883-4 only 0.53 per cent of the swine slaughtered at Berlin were found to be tuberculous, while the records for 1897-8 show 3.9 per cent tuberculous, and later reached as high as 5.79 per cent in one year, although only animals which appear to be perfectly sound are allowed to enter the Berlin slaughterhouses.

For the entire Kingdom of Saxony a percentage of 4.81 has been reached, while in the Kingdom of Bavaria records kept for nine years show that only in the year 1903 were tuberculous hogs found in excess of 1 per cent.

The records from different cities in Great Britain show considerable variation in the percentage of tuberculous animals found among the pigs slaughtered. Thus the Birkenhead town slaughterhouse reports 207 tuberculous pigs out of 22,852 slaughtered (nearly 1 per cent). The veterinary inspector at the London corporation slaughterhouses at Islington found 75 affected pigs out of 15,225 examined (or about $\frac{1}{2}$ per cent), while returns from the inspector of the Glasgow corporation show that 2,553 affected pigs were found among 60,235 slaughtered (4.24 per cent).

Reports from the Netherlands state that during the examination of 368,428 native pigs that were intended for export to London 5,516 tuberculous animals were found, or 1.5 per cent.

In New Zealand during the fiscal year 1907, out of 100,731 hogs examined 5.89 per cent were found affected with tuberculosis, and 4.55 per cent were partially condemned and 0.87 per cent totally condemned.

Taking into account the foregoing figures for the foreign countries mentioned, one may appreciate more accurately the great tribute which each year is paid to this scourge of man and beast by the hog industry. All statistics show after a general style that the greatest increase in tuberculosis among hogs occurs in those sections where the dairy industry is the most advanced, like Copenhagen and Douzig, in Denmark, which show 15 and 70 per cent, respectively (1897), giving as the principal cause of this the use of the by-products of the dairy in the feeding of swine.

PATHS OF ENTRANCE OF TUBERCLE BACILLI.

As a result of numerous experiments conducted on hogs it has been quite conclusively shown that hog tuberculosis is an ingested disease and that the tubercle bacilli are absorbed almost at the beginning of the alimentary canal. The tonsils of pigs have been examined by several investigators, including ourselves, and tubercle bacilli have been found in the apparently normal tonsillar crypts. From the tonsils to the submaxillary glands is but a very short distance and on a direct line with the lymph current in the lymphatic vessels. This fact, taken into consideration with the infection of the submaxillary glands in over 93 per cent of all tuberculous hogs, shows that the tonsils play a very important part as the portals of entry of the tubercle bacillus. Again, the scavenging propensities of hogs, whereby they eat various substances, rough or smooth, hard or soft, sharp or blunt, including wood, nails, wire, etc., make it quite possible for such things to be taken into the mouth with food in such a way as to cause sufficient abrasion of the mucous membrane to permit the entrance of the bacillus, and its absorption by the lymph vessels and subsequent deposit in the submaxillary gland follow. Young pigs at the time of teething are particularly liable to become infected owing to the abrasions of the mucous membrane resulting from the new teeth. Catarrhal conditions of the buccal mucous membranes, such as are observed in stomatitis, also lower the vitality of the epithelial cells, allowing the entrance of tubercle bacilli.

In a few cases the only lesions observed were in the mesenteric glands, which would indicate that the ingested bacilli had safely passed the usual portal of entrance and had been taken up by the lacteals of the intestinal tract and filtered out in the mesenteric lymph glands. Thus Ryder, in charge of the Boston station of the Bureau, has made a careful post-mortem examination of 59,460 hogs, of which number 50 carcasses showed lesions of the mesenteric glands only.

Of far more frequent occurrence are the lesions of the gastro-hepatic glands and of the bronchial glands. In fact, our study of the lesions of hog tuberculosis shows that next in the order of frequency to the submaxillary gland infection comes the combination of the submaxillary with the bronchial glands, then the submaxillary, bronchial, and gastro-hepatic glands, next the submaxillary, bronchial, and gastro-hepatic glands and the liver.

In a certain small number of cases infection probably occurs directly through the respiratory tract, but these instances are extremely rare. Even more infrequent are those cases of tuberculosis which arise as a result of traumatism, especially the infection of castration wounds by the use of infected instruments or otherwise. One boar has come under our observation whose testicles and mucous membrane of the penis were so markedly tuberculous that the genital tract of the sows covered by him could scarcely have escaped infection.

METHODS OF INFECTION.

The most frequent infection of hogs with tuberculosis, as has just been pointed out, occurs, no doubt, through the digestive tract, and in this mode of infection tuberculosis of cattle is very intimately concerned. In those instances in which a marked increase in the number of tuberculous hogs from a certain locality has been noticed and investigated it has too frequently been found that the hogs in question had been fed upon the by-products of a cream separator or that the carcass of some animal succumbing to tuberculosis had been thrown to them for final disposal. The certainty with which either of these two conditions will lead to the infection of the hogs has not heretofore been appreciated in many quarters.

Another source of infection for swine has been shown to exist in the practice of allowing them to run behind a herd of cattle, where the tubercle bacilli excreted with the feces by a tuberculous bovine may readily infect the hogs. Infection of a litter of pigs by a tuberculous sow presents another source of danger. There are a number of other methods of infection which will be mentioned later, but they should be considered of minor importance and must not detract attention from the leading factors in the production of the vast majority of cases of hog tuberculosis, which are unquestionably the milk and feces of tuberculous cattle. When once these are controlled tuberculosis of swine will forthwith be greatly reduced.

The various sources of infection will now be discussed in the following order: (1) The milk of tuberculous cows; (2) the infected feces of cattle and hogs; (3) the feeding of tuberculous carcasses or slaughterhouse offal; (4) the use of diseased brood sows; (5) the sputa of tuberculous attendants, and (6) tuberculous fowls and infected castration wounds.

INFECTION THROUGH THE MILK OF TUBERCULOUS COWS.

Numerous experiments conducted by many scientists in various countries show a great unanimity relative to the ease with which hogs may contract tuberculosis from being fed on milk of tuberculous cows. Thus Gerlach, Zurn, Bollinger, Wesener, Bang, Peuch, Ernst, Pearson, Hills and Rich, and others, have shown that pigs so fed have become tuberculous in as high as 100 per cent of the hogs fed. Furthermore, the experiments of the Bureau of Animal Industry have shown similar results. When hogs were fed on tuberculous milk for only three days the post-mortem examination held one hundred and seven days later showed that 83.3 per cent of the animals had become tuberculous. When hogs received tuberculous milk for thirty days and were allowed to live fifty days longer, 100 per cent of the animals had developed generalized tuberculosis.

That similar experiences occur under natural conditions on the farm has been proved by tracing certain shipments of tuberculous herds to the farm where they were raised and fattened. In one instance a shipment of 74 hogs showed tuberculosis in 61, and investigation brought out the fact that the swine had been fed on the skimmed milk of a creamery in a near-by town. The separator slime from two of the creameries in this town was obtained for experimental purposes, and the inoculation test showed that one of these samples produced tuberculosis in all the guinea pigs inoculated. It is also of interest to know that the hogs slaughtered at the abattoir in this same town for the six months ending June 30, 1907, were tuberculous to the extent of 6.4 per cent, and in March showed the large percentage of 6.69 per cent.

At the present day centrifugal separators for the removal of the cream from the remaining portions of the milk have come into general use in most creameries and upon many dairy farms. During this process the rapid revolutions of the shaft and disks of the machine throw down at the base of the shaft a deposit consisting of dirt, hair, manure, and other impurities which may have found their way into the milk, and mingling with this mass bacteria may also be found in great numbers.

The charge has been repeatedly made that tubercle bacilli are scattered by means of the common practice of distributing the separated milk, or the separator refuse, among the farmers who constitute the patrons of the creamery. Such charges as this should not be made unless some evidence can be presented in substantiation; therefore careful search has been made of samples of the separator sediment from a number of creameries located in widely removed dairy regions to see if they really harbored virulent tubercle bacilli.

When first received at the laboratory this material is examined microscopically. Following this examination all samples, whether

showing the presence of suspicious bacteria in stained preparations or not, are injected into guinea pigs, where the presence of living tubercle bacilli is soon made manifest by the development of tubercular lesions. As a result of such an examination of the products from 15 creameries it has been definitely shown that 5, or 33½ per cent, of the samples examined contained virulent tubercle bacilli.

There are no doubt many creameries to which no milk containing tubercle bacilli is delivered and from which the separated milk when divided among the creamery patrons is free from tubercle bacilli, and consequently furnishes a safe and valuable article of food for the calves and pigs to which it is fed. But there are, unfortunately, others, as above indicated, which receive milk daily from one or more cows so affected with tuberculosis that they excrete tubercle bacilli, and these bacilli find their way in large numbers into the cans of separated milk which are returned to the farmers from these creameries. In this way a single cow with a tuberculous udder may spread the disease to numbers of hogs, and may also infect many farms in a large section of country that have never been contaminated before with this destructive disease. This particular means of disseminating tuberculosis could be absolutely prevented by sterilizing the milk, yet this simple precaution is, in the majority of cases, not taken.

In one State where hand separators are quite frequently used on the farm a lot of tuberculous hogs which contained 36 per cent of tuberculous animals was traced to the farm of the raiser, and the State authorities were notified. The latter made a tuberculin test of the cattle producing the milk, with the result that about 22 per cent of them reacted. It will thus be seen that creameries are not alone incriminated, but the skimmed milk from the hand separator, if it comes from a tuberculous herd, is equally dangerous, and the butter-milk produced at the creamery from the infected separated cream is likewise capable of carrying tubercle bacilli and infecting the animals which consume it.

The one great advantage from a hygienic standpoint which the hand separator has over the public creamery is that the milk from an infected herd is usually fed to the one lot of hogs, while the skimmed milk from the creamery is generally all mixed together in a vat and each farmer takes back with him his pro rata of skimmed milk, which is most likely to be produced by several herds of other people's cattle. Hence the skimmed milk of but one tuberculous herd is liable, as a result of this practice, to contaminate the entire product of the vat into which it is placed. For this reason it behooves hog raisers to see that their skimmed milk has been properly heated before they feed it, and the State authorities to make such heating by creameries compulsory as a simple and easy way of greatly reducing hog tuberculosis.

Borgeaud noticed numerous cases of tuberculosis of the bones in young pigs at abattoirs of Lausanne. Instituting inquiries, he was able to connect the outbreak with the feeding of tuberculous milk. At this same period Borgeaud noticed the arrival of an unusual number of cows affected with tuberculosis of the udder from the neighboring farms. A few years previous to this his attention was called to a farm upon which tuberculosis had assumed the character of an enzootic, two, three, or even more pigs dying each day. The owner was unwilling to admit that the fatalities were due to tuberculosis, but felt sure that his swine must have become infected with rotlauf or cholera. It was, however, learned that the pigs on this farm were being fed upon raw milk from a centrifugal separator. When the practice of boiling the separated milk before giving it to the pigs was inaugurated the disease gradually disappeared from among the hogs shipped from this place.

It is also a common practice on farms to feed to hogs all colostral milk not required by the calf. Unless the cow is free from tuberculosis this is a dangerous practice, although no direct connection with this source of infection has been made in our investigation.

INFECTION BY FECES OF CATTLE AND HOGS.

A very prolific source of infection of hogs with tubercle bacilli, and one which closely rivals tuberculous refuse from public creameries, is to be found in the feces of tuberculous cattle. It is a very common practice to allow hogs to accompany cattle about the feed lot, and while doing this they thoroughly work over the feces, thus saving whatever portions of food have passed undigested through the alimentary tract of the bovine. In herds that are healthy this manner of feeding may be commended because of the economy, but wherever there are tuberculous individuals among the cattle the danger of passing the infection on to the hogs by means of the feces becomes very great.

In a series of investigations which were carried on by the Bureau it was found that the feces of tuberculous cattle are often loaded with tubercle bacilli. To test their virulence, tuberculin-tested hogs were placed in isolated pens where a few shovelfuls of such feces were thrown daily while the hogs were fed upon other food which was free from tubercle bacilli. The result was the infection of 25 per cent of the first lot of hogs and 100 per cent of the second lot that were exposed. The tuberculous condition of the cattle was only shown by the tuberculin test, as they were apparently healthy, having no cough or any visible indications of disease.

A somewhat similar experiment was performed by exposing tuberculin-tested hogs solely to the feces of healthy cattle that were

swallowing small quantities of tubercle culture in their drinking water. The exposure lasted eighty-one days, with the result that 75 per cent of the first lot and 100 per cent of the second lot of hogs contracted tuberculosis.

In a recent examination at the Bureau Experiment Station of the manure passed by 12 cows just purchased from dairy farms in the District of Columbia, and affected with tuberculosis to an extent only demonstrable by the tuberculin test, tubercle bacilli were found by Schroeder in over 41 per cent of the cases, both by microscopic examination and by guinea-pig inoculation. The result of this test led to the suggestion that tuberculous hogs might equally well serve as distributors of tubercle bacilli by means of their feces, and an experiment was at once inaugurated in which a litter of healthy pigs was exposed to possible infection by being brought in contact with the feces of hogs that were known to be affected with lesions of tuberculosis. All other possible sources of infection were excluded; and as there was no development of tuberculosis by any of the pigs, it is probable that the feces of tuberculous hogs may safely be considered less dangerous as a conveyer of infection than the same product of tuberculous cattle.

Only recently a probable instance of infection of hogs by cattle feces came under observation. Of 34 hogs which were marketed in one lot 23 were found diseased, and upon investigation it was ascertained that the owner had a herd of dairy cows, the stable manure from which was thrown into the hog yard. The hogs were given no milk, nor were they permitted to mingle with the cattle, but were pastured and fed on corn and what they could gather from the cow manure. In fact, the latter form of exposure was the only plausible explanation of infection, and this was later accepted when the tuberculin test of the herd revealed 19 out of the 27 cows diseased, which test was confirmed when the cattle were slaughtered and found to be tuberculous, some in an advanced stage.

INFECTION THROUGH FEEDING ON TUBERCULOUS CARCASSES OR SLAUGHTER-HOUSE OFFAL.

It is an all too prevalent custom in some sections for hog raisers to buy up all carcasses of animals that have died from various unknown causes and feed them to their hogs. This is a fertile source of infection with parasites and with whatever infectious disease the animal may perchance have died. Several instances of tuberculous hogs being traced to such an exposure have been found. A prominent example occurred in an eastern abattoir where 31 out of 40 hogs were condemned for tuberculosis. When these animals were traced back to the raiser it was found that he was running a large dairy and that

a dairy inspector had by clinical examination condemned one of his cows for advanced tuberculosis. In order to save something, as the owner stated, from the carcass, he hauled it out to the hog pasture and allowed the hogs to consume it, with the above disastrous results. Hogs that had been previously raised by him had never been condemned, and the lot in question were running on a large pasture, separated from cattle, and apparently had no other opportunity to become infected than by the condemned tuberculous dairy cow.

An equally dangerous source of infection is likewise observed in the methods which obtain among some of the small country slaughterhouses. It is not unusual for these houses to get rid of their blood, intestines, viscera, and other inedible parts by feeding them to hogs, a herd of which is usually kept on the premises. This custom is pregnant with danger and is another fertile source for perpetuating the infectious principle of various infectious and parasitic diseases, and particularly a dietetic disease like tuberculosis. The feeding of offal, etc., to hogs on the premises of abattoirs having Government inspection is not permitted by the Federal meat-inspection regulations, and State and municipal regulations should be equally stringent on this feature, as is the case, for example, in the meat regulations of the city of Philadelphia. As the slaughterhouses where hogs are fed in this manner have no Government inspection, we have no records as to the number that become infected. Such hogs are killed by the butcher on the premises where they are fed, and are marketed as healthy meat.

THE USE OF "TANKAGE" AS FEED FOR HOGS.

Another product of the abattoir, tankage, is in an entirely different class from the above, but it nevertheless has been prominently mentioned from several sources as being the cause of much of the tuberculosis in hogs. As to this, however, we have no confirmatory evidence. Such information as we have is presented below, and it will be seen it points in the other direction.

Tankage is made from the trimmings, inedible viscera, and other parts of the carcass which are placed in the tanks and thoroughly cooked under steam pressure so that it comes out as a sterile product. The grease is removed from the surface and the residue is dried at a high temperature, then ground, screened, and placed in 100-pound bags for shipment. Owing to the dryness of the product there is practically no danger of fermentation taking place.

Tankage, meat meal, and other animal food products as feed for live stock, and particularly for swine, have recently attracted a good deal of attention from the farmers, not only because of the prevailing high price of other feedstuffs but also because of recent experiments indicating that greater growth and more fat can be put on the

animals, and at a less cost per pound, than by any other feedstuffs. Tankage has proven a satisfactory substitute for skimmed milk as an adjunct to corn, experiments showing that hogs can be more quickly and cheaply fattened by such a combination than by corn alone. It is generally agreed among feeders that protein is the most important part of the feeding ration as well as the most difficult to procure and the most expensive. Tankage is very high in protein, varying from 10 to 60 per cent, according to the firm manufacturing it, and is commonly called digester tankage.

It having been stated that the increased use of this material as feed for hogs was the cause of the increase in the number of tuberculous hogs condemned at the abattoirs, many inquiries were sent out by the writers to State experiment stations where tankage had been fed to hogs experimentally, for the purpose of tracing, if possible, any cases of tuberculosis due to the consumption of this product. The following extracts from the replies received are of general interest to hog owners, but fail to implicate tankage in any of the blame for the development of tuberculosis in swine.

Prof. E. T. Robbins, assistant animal husbandman at the Iowa State College, Ames, Iowa, writes:

This includes all the evidence we have in regard to the matter of tuberculosis from packing-house by-products, and it seems to me that at least it does not indicate that these by-products are a probable source of infection.

Prof. J. H. Skinner, animal husbandman of Purdue University Agricultural Experiment Station, states:

I may say that we have always carefully examined the hogs that have been fed tankage in our various experiments with this feed, and we have failed, as yet, to discover any tuberculosis in these hogs. We always have some one present when the animals are slaughtered who makes notes on the various organs, and anything of this sort would not be passed by.

From C. S. Plumb, professor of animal husbandry, Ohio State University, we quote:

I have fed tankage to hogs now for some seven or eight years, and during that time have noted only good results. It may interest you to know that three years ago I obtained some tankage which we fed to our pigs here, and they did not do well; we had swine plague affect the herd and lost a number of young pigs. Suspicion was attached to the tankage, and we discontinued feeding it. The next year, however, the remainder of the tankage, of which there was considerable, was all fed and no injurious effects noted.

Prof. R. S. Shaw, of the Michigan Agricultural College, writes as follows:

We have been using tankage at this institution as a swine food quite extensively for about three years, both in experimental work and ordinary feeding. The great bulk of our hogs are sold alive. Some of them are dressed and placed on the market by Lansing butchers. Some of them are shipped to Detroit and Buffalo by dealers. In these three years we have dressed approximat

about 200 head of hogs in our own little slaughterhouse. No indications of the presence of this disease have been discovered thus far.

The opinions above given are confirmed by certain feeding experiments conducted by the Bureau with tankage mixed with cotton-seed meal in various proportions and fed to 71 hogs for about six months. No indication of tuberculosis was found, after careful post-mortem examinations, in any of the hogs receiving tankage.

INFECTION FROM DISEASED BROOD SOWS.

A case of this character was thoroughly investigated by Clancy, of the Bureau of Animal Industry, and is full of instructive features. It had been noticed that a certain shipper of hogs to the East St. Louis market occasionally sent in a load containing many tuberculous animals, and close inquiry and consultation of shipping records showed that these loads were mainly composed of hogs from one particular farm. An inspector was consequently detailed to visit this place and to discover, if possible, the source of such wholesale infection. In his report to Washington he wrote:

But four cows are milked, and no part of their milk is fed to pigs. The brood sows are kept in several widely separated lots on different parts of the farm, and they are moved about frequently.

A physical examination, it would seem, is of minor importance when we consider the evidence which points conclusively to the fact that several of the brood sows must surely be tuberculous.

It was found that 28 tuberculous hogs were shipped from this farm in May, 1902. In July, 1904, 11 affected hogs left the farm, and in September of the same year 14 others followed, and were condemned by Federal inspectors at the abattoirs. In 1905 there were 27 tuberculous swine shipped from this farm, making a total of 80 animals which had contracted tuberculosis on this farm within a period of four years. It was further shown that a year or two previous to the first appearance of tuberculosis among the hogs in question the owner had purchased some imported cattle from a neighbor who was engaged in importing cattle from England. Some of the cattle from the importer's farm were slaughtered about this time and were found to be so badly infected with tuberculosis that the carcasses were totally destroyed. Tuberculosis was conveyed from the importer's farm to the farm under investigation, and after a time made itself manifest among the cattle on the place, with the result that one of them died. Her carcass was hauled out to the feed lot and turned over to the hogs. After this date constant trouble had been experienced through the development of tuberculosis by the hogs at this place.

We must infer that the brood sows on this farm became affected through eating the tuberculous carcass of the cow, and that, retaining

the disease, they continued to infect their offspring for several seasons following. The sows were retained from year to year while their litters were fattened and sent to market, and it was in these young animals that tuberculosis was found to have developed to such remarkable proportions.

McFadyean reports that a litter of young sucking pigs was referred to him for investigation because they were unthrifty, dull, and purging. The remaining swine of the farm consisted of a boar, three sows, and another litter of young pigs, all of which appeared to be perfectly healthy. The pigs were about 7 weeks old at the time of the examination, and in spite of this early age all of them were found to be affected with generalized tuberculosis. No report of the sow which produced these pigs could be obtained other than the statement that she appeared to be quite healthy with no evidences of mammary tuberculosis. McFadyean considers it more than probable that a post-mortem examination of this brood sow would have revealed either tuberculosis of the generative organs or of the mammary glands. The first pig examined led McFadyean to decide that infection must have occurred previous to birth, while the lesions of the other two indicated a later infection by way of the digestive canal.

In an experiment conducted by the Bureau a sow was artificially infected by inserting a long hypodermic needle under the subcutaneous tissues of the mammæ parallel with the skin, and in withdrawing a few drops of tubercle culture were allowed to flow gradually from the point of the needle. The litter of pigs born to this animal all became tuberculous, although the sow on post-mortem showed only six small subcutaneous abscesses the size of hazelnuts. Another experiment was made with a tuberculous sow having a litter of eight pigs; four of the latter were placed in a pen by themselves into which were thrown the feces of the mother. The negative result of this feature of the experiment has already been referred to (p. 225). The remaining four were allowed to suckle the tuberculous sow, and two of them contracted the disease, thus establishing most positively the danger of perpetuating the disease through the use of diseased breeding animals.

INFECTION BY TUBERCULOUS ATTENDANTS.

Attendants and caretakers who feed and care for hogs should be free from tuberculosis, since hogs are susceptible to human tuberculosis. Bang records the appearance of tuberculosis among hogs on a farm where this disease had never been seen before, which resulted from tuberculous attendants who were in the habit of spitting in the hogs' feed and about the premises.

Dinwiddie, as a result of comparative tests of human and bovine tubercle bacilli, reached the conclusion that pigs "are susceptible to infection with both bovine and human tubercle," and to judge from these tests "bovine tubercle is no more active for these animals than human sputum. The kind of pathological changes induced in the two cases are identical. The liability to generalization of the disease in pigs, a feature which has been noticed by other observers, is noticeable also in these inoculation experiments." In a later review of these tests Dinwiddie states that "pigs were found to be readily infected and prone to suffer from generalized disease by inoculation and feeding with both varieties of tubercle or tubercle bacilli in cultures."

The British Royal Commission on Tuberculosis has also shown that hogs are susceptible to human tuberculosis. This commission considers the power of resistance of hogs to the human tubercle bacillus to be considerably less than that possessed by cattle.

Knese reports the infection and loss of an entire litter of 3-months-old pigs consisting of 11 animals. These pigs had been bred upon the premises from healthy stock, and all possible sources of infection could be eliminated save that of sputum from a tuberculous daughter of the family, who was very sick with tuberculosis of the lungs during the entire summer, and who died from the ravages of this disease in the fall. During the progress of the disease the young woman coughed badly, raising large amounts of expectoration which was collected in a dish at the bedside. This dish was emptied into the yard each morning, then washed out and the wash water likewise thrown into the yard. The small pigs had liberty to run about the yard each day, and undoubtedly became infected through contact with the human tuberculous sputum which was so freely placed within their reach.

In a recent conversation with Ryder, in charge of the Boston station of the Bureau, he informed us that out of a lot of 76 hogs that had been fed upon swill gathered from some of the hotels of Boston 37 were found to be tuberculous at the time of slaughter. It can not, of course, be stated positively that any of these animals were infected through material gained from tuberculous people at these hotels, but because of the possibility of such contamination the case is mentioned. It should be stated that the cattle on this farm were healthy, having been frequently tested in the last three or four years, and there was no other apparent source of infection than the hotel swill.

INFECTION FROM TUBERCULOUS FOWLS AND THROUGH CASTRATION WOUNDS.

The frequent association of pigs and fowls has suggested the possibility in European countries that in some cases tuberculosis of hogs

may result from exposure to chickens affected with tuberculosis. As avian tuberculosis is extremely rare in this country, little importance may be attached to this method of infection, although the finding of avian tubercle bacilli in hog tissues by Weber and Bofinger indicates that hogs are susceptible to this form of the disease.

The danger of infection of the scrotum at the time of castrating hogs through the contaminated knife of the operator or otherwise has been reported by Meyer. This method of becoming diseased is likewise of such rare occurrence that to mention it is sufficient for our purpose.

SYMPTOMS OF TUBERCULOSIS IN HOGS.

Few hogs ever show by outward symptoms that they are affected with tuberculosis. In fact, the hogs that disclose tuberculosis at the time of slaughter are frequently the finest appearing animals in the drove when they are brought to the abattoir. Should indications of tuberculosis be present they will usually consist of a general appearance of unthriftiness, which might result from other diseases and therefore does not afford any very definite indication that tuberculosis is present.

Where the disease has progressed to an advanced stage of generalization various symptoms may appear. Abdominal tuberculosis is frequently accompanied by general disturbance of the digestive functions, and constipation or diarrhea may be shown. Advanced pulmonary tuberculosis will be shown by a persistent dry, harsh cough, and by acceleration in breathing, especially on exercise. This cough is similar to that caused by lungworms and can not be differentiated from it.

Interference with both respiratory and digestive functions may be seen when the disease is widely generalized, and the systemic alterations will be shown by progressive emaciation and weakness. Localization of the disease in bones or joints may produce lameness and other visible indications, but these are comparatively very rare.

In the majority of cases no intimation of the presence of the disease will be given until the animal is slaughtered, and the discovery of a number of tuberculous hogs in a drove of apparently prime, well-finished animals is often the cause of great surprise and disappointment to their owner, and in such cases the lesions may be sufficient to prove the disease generalized and the tubercle bacilli to be so widely distributed as to render the meat unfit for food purposes.

Forty-four hogs that had been fed upon the milk of a tuberculous cow for a period of two months at the Oklahoma Agricultural Experiment Station were subjected to official inspection at the abattoir, and 21, or 47.72 per cent, of them were condemned as tuberculous. The effect of tuberculosis on the physical condition of these hogs

was not very marked, as may be seen from the following statement of Doctor Lewis:

Some of the animals that showed a generalized condition of the disease at the time of the post-mortem examination had had the disease almost a year, yet they were in apparently good physical condition. In one that died from the effects of the disease the physical condition was not such as to cause suspicion of generalized tuberculosis. In fact the entire lot of diseased hogs were in a marketable condition so far as flesh was concerned, and a number of them were killed under official inspection, their condition being such that they were considered fit for market.

Among a lot of hogs in which tuberculosis is known to exist it is occasionally possible to select a tuberculous individual by palpation of the throat, when enlarged cervical lymphatic glands may be detected, which will afford a reasonable ground for a suspicion of tuberculosis. In such a drove a sow with swollen mammae would likewise suggest the presence of a tuberculous mammitis, but these cases are extremely infrequent.

In those cases where the disease is not characterized by prominent symptoms, but where the animals are suspected of having the disease, the tuberculin test is recommended. This makes it possible to slaughter the reacting animals in the early stages of the disease and thus obtain some remuneration for the carcasses and at the same time get rid of the infection. This is especially important in holding over brood sows, as our experiments have indicated that the milk of these sows may contain tubercle bacilli and thus infect the young pigs.

THE TUBERCULIN TEST.

In reviewing the questions of detection and eradication of tuberculosis in hogs it is noticeable at once that there are but few recorded instances in which reliable tuberculin tests have been made. This may be due to the fact that the temperature of a hog is subject to rapid changes under conditions which would not cause noticeable variations with cattle. These alterations of temperature in individual hogs are so great within short spaces of time, and from apparently insignificant causes, that it seems at first thought that no change caused by the injection of tuberculin could ever be sufficient to permit one to reach any definite conclusion as to the presence or absence of tuberculosis.

In the experiments of Schroeder and Mohler, of the Bureau of Animal Industry, recorded in Bulletin 88, it was found desirable to keep the hogs as quiet as possible during the test, it having been shown that excitement affects the temperatures of hogs very quickly. Each hog was therefore placed in a rectangular crate about twelve hours before the first temperature was taken, and remained in this confinement continuously until the tuberculin test was completed. The

crates, while large enough to permit the hogs to get up and down easily, were still close enough to prevent their turning around or moving backward and forward to such an extent as to interfere with the insertion of the thermometers. Crates that are made 4 feet long, 1 foot 2 inches wide, and 2 feet high, inside measurement, have proven entirely satisfactory in restraining hogs weighing from 50 to 150 pounds. Unless use is made of crates, or of some other satisfactory means of restraint, it is difficult, if not impossible, to obtain trustworthy temperatures of hogs.

The dose of tuberculin used was estimated on a basis of $\frac{1}{2}$ c. c. for each hundredweight, or fraction thereof, of the weight of the animals tested. For instance, a pig weighing 75 to 100 pounds would receive $\frac{1}{2}$ c. c. of tuberculin, while one weighing 150 to 200 pounds would receive 1 c. c. The injections were made directly under the skin at the inner surface of the thigh, and in no instance were any harmful results noted following the puncture.

For a practical tuberculin test it has been found sufficient to have the temperature of the hogs taken every two hours from 8 a. m. to 6 p. m., inclusive, on the day of injection, and at the same hours on the day following, with the tuberculin injection made at 10 p. m. on the first day. The temperature before injection should be taken as frequently as after injection, and at corresponding hours, because of the very erratic character of the temperature of hogs and because of the slight circumstances that may inadvertently be the cause of marked variations. It should especially be borne in mind that the value of the results obtained depends entirely upon keeping the hogs absolutely quiet during the whole of the test, and this point may be more readily gained if the animals are kept in their crates for twelve hours at least before the first temperature is taken.

In reaching a decision as to the presence of tuberculosis in a hog, as shown by the temperature readings, it is somewhat unsafe to base a condemnation upon the comparison of the maximum reading before injection with the maximum of the day following, but by averaging the temperatures for each of the two days during which they have been taken one is enabled to reach very satisfactory conclusions by comparing these averages. It is essential that the temperatures should be taken at corresponding hours on each day of the test, if results are to be determined by means of averages. By this method it was found in a test experiment with 68 hogs that only two failures (less than 3 per cent) occurred. In these tests no hog was condemned as tuberculous until it had shown a persistent average elevation of temperature of 1° F. throughout the second day. In the two failures mentioned one tuberculous hog failed to react, and another animal gave a reaction, but at post-mortem examination no tubercular lesions could be found.

A report has been received from Doctor Luckey, State veterinarian of Missouri, which shows that hogs may be tested satisfactorily and to good advantage with tuberculin if handled quietly and kept so closely confined that no chasing or driving will be necessary at the time of taking temperatures.

As a proof that carefully bred pedigreed swine are not necessarily more susceptible to tuberculosis than the more common varieties, mention is made in the Veterinary Journal of the testing with tuberculin of a number of purebred animals intended for export to Finland. The temperature of each pig, which was numbered for identification, was carefully taken, the average for the boars being 39° C., and for the sows 39.16° C., the higher temperatures of the sows being thought to be due to excitement, owing to their racing about when let out of their pen. The temperatures of all of the pigs were higher at the preliminary reading than at subsequent testings, probably the result of being caught and handled.

The tuberculin was injected at 10 p. m., and the temperature of each pig was taken at 7 o'clock the following morning and each two hours afterwards until the veterinarian of the purchasing party was convinced that no trace of tuberculosis existed in any of the animals. The variations in the temperatures of the various pigs were comparatively slight, that of one boar being from 39.2° to 38.5° C., and of one sow from 39.4° to 38.5° C., the highest being in each case the one taken first. The average temperature of all the pigs at the various testings was 38.6425° C., or nearly 0.3° C. less than those first taken.

LESIONS.

The vitality of hogs or their powers of resistance to disease are necessarily lowered by the unnatural conditions which frequently obtain in hog raising, namely, the forced feeding for fattening and the small feeding pens in vogue in certain districts. When the enormous growth of a hog is considered, when it is realized that in the short space of eight or ten months its development is frequently 250 to 300 pounds—a proportionate increase of weight unknown to any other species of domestic animals—the great metabolic changes which must necessarily occur can be appreciated. Such rapid development is very likely to take place at the expense of the disease-resisting powers of the animal.

When tuberculosis results the lesions usually observed are discrete and of a chronic type, at times retrogressive and at other times slowly progressive, as manifested by calcareous deposits and fibrous encapsulation. It is not infrequent, however, that a more extensive and spreading disease is seen, and the lesions indicate a severe infection and rapid generalization of the bacilli, which in these animals may quickly follow the initial attack. And whether the disease assumes

an acute, subacute, or chronic type, tuberculous growths may soon be found attacking lymph glands in widely separated parts of the body. Indeed, a most extensive development of the disease has been reported by McFadyean in pigs from 8 to 10 weeks old, born of healthy parents and evidently infected by tuberculous skim milk. In these cases the lesions had not only undergone extensive caseous degeneration, but had even become partially calcified. Furthermore, he reported the observance of pigs 6 to 8 weeks old with generalized lesions which had become more or less calcified.

As soon as the tubercle bacillus invades the tissue changes develop, resulting in the formation of nodules or tubercles which may be either translucent or of a yellowish-white color. At first these tubercles are isolated and discrete, but later they may coalesce and form large areas of tuberculous tissue. Microscopically, the tubercle is formed of the same elements as are noted in the tubercles of other animals, namely, epithelioid, lymphoid, and giant cells. The earliest development of the tubercle consists of the invading bacilli surrounded by round cells. In a short time these cells are circumscribed by a layer of epithelioid and giant cells, which in turn are surrounded by a zone of lymphoid cells. As the tubercle grows the cells in the center of the tubercle die, become fragmented, and form a necrotic mass which enlarges as the tubercle increases in size. Sometimes these tubercles become indurated with fibrous tissue, or may go on to calcareous infiltration, or the necrotic areas may be surrounded by fibrous tissue elements, all of which cause the glands to be enlarged, hard, and knotty. These cases of calcareous infiltration in the hogs of this country are much more frequent than the Old World literature would lead one to believe occurs in European hogs.

One peculiar condition which is at times observed in tuberculous glands and which may prove perplexing to some inspectors is the arbor-vitæ or dendritic appearance which these lymph nodes may assume as a result of hyaline degeneration. This rather unusual form of a tuberculous gland probably arises from the lymph bringing to the node the tubercle bacilli, which, acting as an irritant, lead to the change, and which, being arrested in the nodes involved, permit the other tissues to escape unless further exposure follows. The delicate capsule and connective-tissue trabeculæ of these glands at first become excessively hypertrophied at the expense of the lymphoid elements. The tissue then partly or entirely undergoes a process of hyaline degeneration, making a tortuous, almost dendritic, course of this form of degeneration not unlike the branching of the arbor-vitæ of the cerebellum. Many of the lymphoid cells, particularly those in the vicinity of the connective-tissue septæ, suffer a similar fate. No necrotic areas have been observed, but isolated and clustered tubercle bacilli

may be seen in the earlier stages in the hyaline areas, which evidently retards the multiplication of the micro-organisms and brings about a partial process of healing, as in the more advanced stages tubercle bacilli can not be discovered either by the microscope or animal inoculations.

As a general rule, the lymph glands become enlarged, and caseation usually starts at several points where the tubercles had started, causing numerous small yellowish foci often surrounded by a reddened, inflamed zone. These areas are composed of degenerated gland substance, and are sometimes intermingled with pus; at other times they are of a cheesy consistency, and more frequently gritty through the deposit of calcareous particles.

The lesions, therefore, consist first of miliary granulations, which become caseous and which may rapidly become calcareous. Even in the absence of tubercle bacilli, the microscopic picture of stained sections shows the typical tubercular follicles almost always rich in giant cells. Furthermore, the insertion of a small piece of the susceptible tissue under the skin of a guinea pig will usually result in the production of the disease in three or four weeks, when the animal may be chloroformed and a diagnosis made.

As the disease is essentially produced by ingestion, the glands and tissues associated with the digestive tract are the most frequent seats of infection. Indeed, the superior cervical glands (in almost all cases the submaxillary gland) are nearly always affected, as at the post-mortem examinations held by Bureau inspectors over a consecutive period on 120,000 tuberculous hog carcasses, 93.3 per cent were found to contain lesions in these glands. The large tonsils and the large number of lymph sinuses in the lymph glands probably account for this great frequency. Next in importance are the bronchial glands, of which 27.2 per cent were diseased, while the gastro-hepatic chain of glands was involved in 21.6 per cent of the cases. In all these cases the lesions may involve the entire lymph structure, or only the central or several irregular points, and may be either caseous, calcareous, or caseo-calcareous. The mesenteric lymph glands showed lesions in 18.1 per cent of the carcasses examined. The liver was affected in 9.2 per cent of the cases, and showed either yellowish miliary foci, which were caseous and scattered, not only on the surface but also in the parenchyma, or the larger, irregular nodules, varying from a hemp seed to a shellbark in size. They are at times quite fibrous in consistency and may contain a caseous center, or calcification may occur as the disease advances and the alterations become more considerable. The lungs are the next tissue to be most frequently affected, as is represented by 7 per cent of the carcasses above recorded. The morbid anatomy of the lungs in this disease simulates



TUBERCULOUS LUNGS OF HOG.

W. H. HARRIS, ARTIST.



TUBERC

IMAL SPLEENS OF HOGS.

that observed in human tuberculosis more than in cattle tuberculosis. In fact, the disease bears many points of similarity to infantile tuberculosis in the human. There may be tuberculosis pneumonia involving large areas of the lungs, causing collapse of the marginal portion. There may be irregular-sized grayish or yellowish areas of caseation, as is so often seen in cattle; but not infrequently there are observed large numbers of miliary gray or translucent foci, showing evidence of generalization as a result of the bacilli being disseminated by the blood stream. (See Pl. II.)

The picture presented by tuberculosis of the spleen, which showed lesions in 3.8 per cent of the above carcasses, is very peculiar to one who is familiar only with cattle tuberculosis. The spleen is usually darker in color and the surface is quite rough and nodular, depending upon the number and size of the tubercles. Unlike the spleen of a tuberculous cow, these nodules occur not often on the serous membrane, but in the parenchyma. They vary from the size of a half pea to as large as a shellbark. The external pale or light-red nodules are raised above the surface of the organ and frequently show fibrous tissue bands radiating from the centrally necrotic area. (See Pl. III.)

The lesions observed in the mediastinal glands are similar to those in other glands and were noted in 1.8 per cent of the cases, while the sublumbar glands were found affected in 0.9 per cent of the carcasses. The serous membranes may show an eruption of tuberculous granulations, and these have been noted on the pleura in 0.1 per cent and on the peritoneum in 0.006 per cent of the cases. The generative organs are rarely affected. The bones, however, are more frequently attacked, those of the vertebral column, pelvis, and of the articulated extremities showing tubercular affection in 0.007 per cent of the carcasses. Tuberculosis of the muscles has been noted, but not so frequently as of the bones and joints. The lesions are usually rather limited to one region. Their aspect varies. They may be rounded, isolated nodes of the diameter of a pea or bean, composed of a fibrous capsule, with caseous contents. In other cases the muscles are sown with whitish-gray confluent tubercles, with centers that are usually calcified early in the development of the disease. The extreme rarity of lesions in the kidney is shown by the finding of but 3 cases in the 120,000 tuberculous carcasses. As examinations of the prepectoral, prescapular, and inguinal glands were not made in all instances, no percentages are given for them.

Occasionally also ulcers and tuberculous nodules are noticed on the mucosa or submucosa of the small intestines, especially of young pigs, but these likewise are rare, and when found usually accompany generalized lesions elsewhere in the body.

COMPARISON OF THE TUBERCULOUS LESIONS OF HOGS AND CATTLE.

While the lesions in hogs may be considered in their principal features like those in cattle, there are some points of difference which may be readily noted. As the disease in the former animals is essentially a food tuberculosis, the primary seat of infection is almost universally along the alimentary canal. The submaxillary glands are more frequently affected than any other tissue in hogs, while in cattle these are quite infrequently diseased. In fact, the submaxillary glands of hogs bear a somewhat similar position to the retropharyngeal glands of cattle, although the former are more frequently affected in hogs than the latter are in bovines. The lungs are less frequently diseased and generally secondarily involved, not primarily as in cattle. Furthermore, the pleura and the peritoneum are even less commonly affected than the lungs. The liver and the spleen, especially the latter, are more often diseased in hogs. The mammary glands of hogs are less frequently affected than in cattle, while the bones, joints, and muscles are more liable to disease in hogs. The lymph glands, even those remotely situated, are more frequently affected than in cattle (with the exception of the mediastinal gland, which is only occasionally diseased in hogs), and there is a very large percentage of this disease in hogs which only shows involvement of one, two, three, or even more groups of lymph glands without regular secondary infection.

Ulcers in the intestines, while infrequent in both species, are probably more commonly observed among swine. The formation of grape-like clusters on the parietal serous membranes is quite infrequent, and when it is seen it usually results from contact with an adjacent tuberculous organ. The lesions undergo calcification much earlier in hogs, and this form of degeneration occurs as often as, if not oftener than, in cattle, and frequently takes place when the lesions are quite small. The tubercle bacilli are quite elusive on microscopic examination, but are more readily seen in our experience with hog lesions than with bovine. Finally, unlike the disease in cattle, tuberculosis of hogs is most frequently seen at the abattoirs in animals under 1 year of age, due, of course, to the fact that the majority of hogs are marketed at this age.

RELATION OF HOG TUBERCULOSIS TO MEAT INSPECTION.

The post-mortem inspection of hogs by the Bureau officials is very thorough, and is so arranged that tuberculous carcasses are quickly separated from those that are healthy. The various phases through which the hog passes after his arrival at the stock yards, where he is yarded, sold, weighed, driven to the packing house, killed, scalded, and run through the scraper, do not particularly concern us until we

meet him at the point where, lying on the traveling table, his head is almost severed from the body. Here he is examined by a veterinary inspector of the Bureau, who palpates and, if necessary, incises the submaxillary glands which have been exposed by the cut just made by the butcher for removing the head. Should these glands prove to be healthy, the hog is allowed to pass down to the rail unmolested; if on the other hand these glands are seen to be tuberculous the animal is marked and is then run into a separate compartment called the retaining room, without being eviscerated. Most of the tuberculous animals are detected here at the header's bench, our records, as previously mentioned, showing that 93.3 per cent of the tuberculous hogs support lesions in the glands in the region of the throat.

From the header's bench the hogs which have not been tagged are sent along the rail to the gutter's bench, where another veterinary inspector is stationed, whose duties consist in examining each hog, giving special attention to the viscera. His search is not limited to the detection of tuberculosis, but he must watch for any of the diseases proscribed by the regulations of the Bureau. As there is a certain percentage of hogs that show tuberculosis in the visceral organs without giving any evidence of the same in the cervical glands, the inspector at the gutter's bench is able to detect a number of tuberculous subjects in addition to those already tagged by the veterinarian at the header's table. In this case the inspector is guided by the appearance of the lesions in the liver, spleen, lungs, or visceral glands.

Another inspector has recently been installed at the point on the line where the carcasses are split, it having been found that occasionally vertebral lesions and lesions of the serous membranes will exist, even when the visceral organs are apparently normal.

Returning to the hogs which were tagged by the inspector on the heading bench, these are passed along to the retaining room, where they are eviscerated by a separate lot of butchers, using separate tools, under the supervision of a fourth veterinary inspector. By this method the affected parts or tissues are prevented from coming in contact with the healthy meats and are passed directly from the retaining room to either the "condemned" room or to the offal tanks. In the retaining room by this time there will be many hogs on the rail that are only slightly affected with tuberculosis, and these are now beheaded, split, trimmed, and passed on to the cooling rooms.

It is not a very difficult problem to pass judgment on the carcass of a hog affected with tuberculosis when the lesions are slight on the one hand, or when they are widespread on the other. Most sanitarians are agreed to pass the former class for food, after removing the diseased parts, and to condemn the latter class. In the great majority of hogs retained by our inspectors the lesions are local, even

though one or more groups of organs are affected. It is not unusual to see hogs with lesions in the submaxillary, bronchial, and hepatic lymph glands, or any combination of them, in which the foci are of the same character, size, and consistence, and apparently of the same age, and in these cases the animals are judged to be infected by a limited exposure with resulting lesions in these various glands. Indeed; from experiments performed by the Bureau, where hogs were fed for two feedings on cultures of tubercle bacilli, it was observed that apparently some of the tubercle bacilli entered the submaxillary glands, while others lodged in the bronchial and hepatic glands at about the same time. These are purely primary lymphatic invasions, and these are the cases in which it is customary for the inspector to remove all diseased parts from the carcass and allow the remainder to be passed as suitable for food.

The principle governing such disposal of this class of carcasses is that, there being no evidence that the tubercle bacilli have been taken up from the portal of entry to the body by the blood vessels, there could have been no scattering of such organisms through the muscular parts of the carcass, and these may therefore be eaten with impunity. It is in cases of this class that danger from the development of toxins has been suggested. This, however, has been disproved by the experiments of Eber and ourselves.

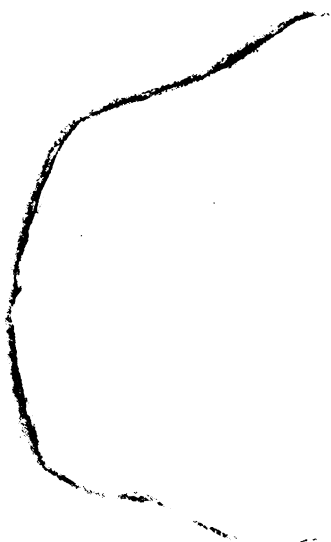
The disposal of cases of generalized tuberculosis is likewise an easy matter, for it is evident that the infectious organisms have gained entrance to the blood vessels, and by this means have been conveyed to all parts of the carcass, infecting the meat more or less completely. The rendering of such carcasses in the offal tank is the only rational disposal that can be made of them.

There are, however, other cases in which the development of disease has reached a stage which may admit some discussion as to the advisability of using the meat for food. Many tuberculous hogs are found that give no evidence of cachexia or wasting, and that show on examination that the disease has not become generalized or extensive, although it has advanced beyond the point of primary glandular infection. Here the inspector must act carefully, trying to avoid the waste or loss of any meats that may be safely converted into human food, and at the same time being sure that nothing of a dangerous character is allowed to enter the cooling or cutting rooms.

If the lesions of tuberculosis in the animal under consideration are so located that they may be readily removed, a third method of disposing of the carcass may be selected. The carcass may be carefully trimmed, the tuberculous parts being consigned to the offal tank, while the trimmed meat, comprising the bulk of the edible portions of the animal, is placed in the lard-rendering tank, where it must be



LUNG OF HOG WITH VERMINOUS PNEUMONIA.



1



2

FAT NECROSIS INVOLVING (1) THE OMENTUM AND (2) THE PANCREAS OF HOG.

cooked by steam at a temperature not lower than 220° F. for not less than four hours for the extraction of the lard which it contains. This temperature, of course, is sufficient to destroy any bacilli that may possibly be present in the meat.

DIFFERENTIAL DIAGNOSIS.

There are but few diseases which are liable to be mistaken for tuberculosis in the hog, but under certain conditions verminous pneumonia, caseous lesions following an attack of swine plague, fat necrosis, pyemia, echinococcus cysts in the liver, or degenerations of the lymph glands caused by invasions of the young forms of the parasite known as *Lingulatulula taenioides*, may cause lesions bearing considerable resemblance to those of tuberculosis.

In the lesions following swine plague it will be found that there is no involvement of the thoracic lymph glands, which practically always become affected with tuberculosis in all tubercular infections of the lungs. Mistakes between this disease and tuberculosis should not be made, as the lungs in cases of swine plague will not show the grayish areas simulating tubercles until the disease has run a protracted course, allowing the areas of the lungs to become caseated. Examination of the skin of the hog and the internal viscera will likely give evidences which will greatly aid in a differential diagnosis.

Cysts of the *Echinococcus multilocularis* in the liver may at times be confusing, but they are usually whiter in color than tubercular lesions of the same size, and when cut open the central contents of the cyst may be readily removed, which condition is totally unlike that to be found in tubercular nodules. In this affection the adjoining lymph glands are not changed as they are in cases of tuberculosis.

Invasion of the lungs of swine with strongyles or roundworms may produce lesions very similar at first glance to those of tuberculosis (see Pl. IV), but the adjacent lymph glands are not involved. Careful examination of the air tubes by opening them will readily disclose the worms to the naked eye, and thus establish the verminous origin of the lesions. It is said that the pseudo-tubercles which occur with this condition are in reality due to the encystment of the female worm or of the ova and embryos in the air sacs and cells. The long-necked tapeworm, *Cysticercus tenuicollis*, may invade the lungs and cause similar pneumonia, but this only rarely occurs. The finding of worms in the various visceral organs of the hog should serve to direct the attention to the air passages in cases of difficult diagnosis, as it is very common to find a verminous invasion of the lungs accompanying an invasion of the stomach or intestines.

Relative to the mistaking of lesions caused by the invasion of *lingulatus* larvæ into the lymph glands of hogs for lesions of tuberculosis, Edelman gives the following:

The recognition of the larval site is not difficult if the affected areas and glands are cut open. They may be mistaken for tubercular areas if it is not recalled that—

1. Tubercular areas do not preferably occur in the peripheral zones of the lymph glands, but are usually found in their cortical portions.

2. Tubercular areas caseate from the center outward, and are surrounded by a gray peripheral layer, while *lingulatus* foci possess a uniform caseous consistency.

3. Caseous tubercular areas are yellow, while caseated *lingulatus* areas are greenish in color.

4. In beginning calcification tuberculous areas retain their yellow color; the pentastomum areas on the contrary turn gray; and

5. In *lingulatus* areas the larvæ or their hooks are demonstrable.

In pyemia the liver and lungs are the principal seats of the metastatic abscesses, which are soft and frequently encapsulated, but, unlike in tuberculosis, the corresponding lymph glands do not become caseated. Furthermore, there may be evidences of a general blood infection, as cloudy swellings of the organs, hemorrhages in the kidneys, lymph glands, and serous membranes, or a suppurative wound on the surface of the body through which the pyogenic micro-organisms entered.

Fat necrosis is generally considered to be the result of the fat-splitting ferment of the pancreas acting upon living adipose tissue. The fat is split up into fatty acid and glycerin by this ferment; the glycerin is absorbed and the fatty acid which is left combines with the salts to form a soap. The lesions occur in the form of dead-white, slightly raised, opaque, and grumous areas of variable size, and usually of a more or less circular outline. (See Pl. V, fig. 1.) They are of firmer consistence than the adjacent fat. In the majority of cases the lesions are confined to the immediate vicinity of the pancreas, and are found in the fat between the lobules and immediately surrounding the gland. (See Pl. V, fig. 2.) It is quite common, however, to find them considerably removed, and appearing in any part of the peritoneum, on the kidney fat, and even as far back as the pelvic cavity. The fat of the abdominal wall is frequently affected, and may contain many small areas from the size of a pinhead to that of a half dollar, or it may be so severely involved that very little normal fat will be found lining the abdominal wall. These patches may also occasionally appear under the parietal pleura and the parietal serous membrane of the pericardium. The lesions of fat necrosis are usually secondary to some alteration of the pancreas, while in tuberculosis the pancreas is very rarely involved, and then only in

conjunction with lesions in other viscera. Furthermore, the caseation so characteristic of tuberculosis is absent in fat necrosis.

PREVENTIVE MEASURES.

REMOVAL OF AFFECTED ANIMALS.

The first step to be taken in preventing the further spread of tuberculosis is to remove all affected animals, whether hogs or cattle, from the premises, as these will only serve as sources of infection so long as they are allowed to mingle with healthy animals. In dealing with affected herds of cattle it has been found best in most cases to apply the tuberculin test to the entire herd as a means of selecting the tuberculous animals, but with a drove of hogs in which tuberculosis has appeared there can be no doubt that the best and surest method of procedure will in nearly every case be found in the slaughter of the entire drove as soon as they can be put in a marketable condition. They should be slaughtered at an abattoir under Federal inspection, so that proper disposal may be made of affected carcasses.

This means of removing from the farm all of the centers of infection which exist among its swine is made possible and practicable by the ease with which a new drove may be built up from fresh foundation stock. With cattle the offspring seldom number more than one to a cow in a year, and the young cow does not produce until 2 years of age. With swine reproduction may be expected when the young sow is 1 year old, and instead of producing but one at a birth from six to ten may reasonably be expected. If properly handled, the first litter of young may be weaned in time to allow the sow to farrow again the same year. This shows how very rapidly a farm may be stocked with healthy swine after the total slaughter of a tuberculous lot. The early age at which the sow may be bred, her capacity for breeding twice a year, and the plural number of her offspring are forceful arguments for the total destruction of every diseased drove of hogs and the breeding up in clean, healthy quarters of a sound, healthy drove in its stead.

As tuberculosis seldom attacks the swine of a farm except through tuberculous cattle, the tuberculin test should be applied to all of the cattle on the place, and all tuberculous animals among them should be destroyed at the time of disposing of the hogs.

DISINFECTION.

With the hogs all removed from the place and no tuberculous cattle remaining, attention should next be given to disinfecting the premises, so that no center of infection may be left to contaminate future purchases of live stock. The disinfection of pens and stables may be accomplished by thoroughly cleaning them, scrubbing the floors with

hot water, brushing down all loose dust from the walls, and tearing out all woodwork which has become partly decayed. The interior of the pens or stables should then be carefully covered with a coating of lime wash containing 1 part of formalin to 30 parts of the lime wash, or 4 ounces of formalin to each gallon of the lime preparation. The yards should be carefully cleaned at the same time, especial attention being given to the removal of all rubbish and litter from the dark, shady corners. Lime, or a 3 per cent solution of carbolic acid, may then be sprinkled upon these dark portions of the yards. In all of the open portions of the yard the action of the direct rays of the sun will very quickly destroy all the virulence of the scattered tubercle bacilli.

The premises now being cleansed, healthy foundation stock may be procured, and if proper attention is given to keeping the cattle of the farm free from tuberculosis and to supplying the hogs with suitable food, the owner may feel every reasonable assurance that he has seen the last of tuberculosis among his swine. The trouble, time, and expense required will be more than repaid by the advantages gained.

It has been quite conclusively shown that swine acquire their infective tuberculous material from cattle, mankind, or poultry, but principally cattle.

Tuberculosis can not develop spontaneously in swine, but must be acquired from some outside source, and the farmer whose yards and stables have been thoroughly freed from the disease need fear no reappearance of the disease, except when introduced from some outside point of infection. In case the disease has only recently been introduced among the hogs it would be advisable to apply the tuberculin test that the affection may be detected in the early stages, in order that the hog raiser may clean up his herd with as little loss as possible.

PASTEURIZATION OF ALL MILK PRODUCTS USED FOR FEED.

The heating of all milk when received at public creameries to 176° F., or 80° C., has been found most effective in preventing the spread of tuberculosis to the animals consuming the by-products of such creameries. Denmark was one of the pioneers in this movement, having in 1898 passed a law requiring all skimmed milk and all buttermilk to be warmed to 185° F. before it could be distributed from any creamery to its patrons for feeding purposes. It was found, however, that this degree of heat was harmful to the product, and in 1904 the required temperature was reduced to 176° F., experiments having proved that no tubercle bacilli could withstand this amount of heat. In practically all of the Danish creameries from this latter date the whole milk has been heated to the required point,

thus assuring butter that is free from tubercular organisms, as well as by-products that are safe for use in feeding hogs or calves. The result of these regulations has been most satisfactory. The spread of tuberculosis to farms previously free, through the skimmed milk or the buttermilk from creameries, has been very markedly checked, and suppression of the disease in hogs has been plainly noticeable.

Treating of creamery milk as a cause of the spread of tuberculosis among hogs, Moussou makes the statement that sterilization of the by-products of creameries and cheese factories results in the disappearance of tuberculosis of an alimentary origin among the hogs fed with them, and the hog owners do not longer fear losses from this disease.

Borgeaud has cited an instance in which a serious outbreak of tuberculosis among hogs was overcome by boiling all of the separated milk before feeding it to the subsequent litters of young pigs.

PROPAGANDA AMONG FARMERS AND DAIRYMEN.

While pamphlets, popular articles, and public notices would be extremely useful in eradicating tuberculosis in swine, it would probably be more satisfactory to explain to the hog raiser by word of mouth the methods to be followed. As this suppression of tuberculosis is entirely voluntary on his part, a powerful propaganda is of the greatest value, and the veterinarian is the best equipped man available for the work. The State should also assist by employing veterinarians to give public lectures in towns and townships, as is being done at present in Sweden. We now have absolute knowledge that the vast majority of cases of hog tuberculosis are produced by—

1. Raw milk and slime from creameries.
2. Hand-separated milk from tuberculous cattle.
3. Feeding behind tuberculous cattle.
4. Feeding tuberculous carcasses.
5. Feeding slaughterhouse offal.

It therefore behooves veterinarians to educate their clients as to the proper methods of preventing this disease, as they would recommend a proper feeding ration or proper construction of a stable. Hog raisers should be instructed to (1) scald all raw products returned from the creamery; (2) to test their cattle if a hand separator is used on the farm, or in the absence of such a test, to scald the skimmed milk; (3) to let the hogs feed behind cattle only when the latter have withstood the tuberculin test; (4) to feed carcasses of animals that have died from any cause, or offal from the slaughterhouse, only after the meat and offal have been thoroughly cooked.

Sooner or later the packer and slaughterer are going to buy hogs subject to the post-mortem inspection, as they are at present doing in some of the large packing centers with certain classes of female

cattle; and the hog raiser who continues to fatten his hogs with tuberculous material should be made to sustain the losses arising from his lack of knowledge, skepticism, or indifference. The innocent purchaser, who can not be familiar with the methods of feeding in vogue on the farms of the different breeders, should not be expected to bear such losses, nor should the intelligent hog raiser who produces healthy hogs by carrying out minutely the known and proved methods of prevention be obliged to bear a portion of the burden caused by the careless or ignorant hog raiser, as is the case at present. To-day the hog buyer must make his purchases with the absolute knowledge that a certain proportion of his purchase will be condemned for tuberculosis, and as the post-mortem examination is the only key to the extent of the disease, the careful breeder must suffer equally with the careless one. This is not equitable. When the packer buys subject to the post-mortem results the intelligent hog raiser will get more for his healthy hogs than he does now, and the ignorant breeder will get less for his tuberculous hogs, which is as it should be.

It would be money well expended if butchers and packers who are losing so much from hog tuberculosis would employ veterinarians in their vicinity to write popular articles giving correct views on how to suppress tuberculosis on the farm and mail them to their hog shippers and hog raisers in furtherance of this plan of eradication. Extermination of hog tuberculosis is practicable, relatively easy, and should be attained without delay before the disease has gained too much headway.

One of the favorable steps in this direction, and one that will undoubtedly tend to check the advance of tuberculosis, is the enforcement of laws similar to the following, which have been enacted by the States of Iowa and Minnesota:

Laws of the thirty-first general assembly of Iowa (1906).

Be it enacted by the general assembly of the State of Iowa:

SECTION 1. That every owner, manager, or operator of a creamery shall before delivering to any person any skimmed milk cause the same to be pasteurized at a temperature of at least one hundred and eighty-five (185) degrees Fahrenheit.

SEC. 2. Whoever violates the provisions of this act shall, upon conviction, be liable to a fine of not less than twenty-five (\$25) dollars nor more than one hundred (\$100) dollars.

General laws of Minnesota for 1903, to prohibit and prevent the manufacture or sale of unhealthful or adulterated dairy products.

Be it enacted by the legislature of the State of Minnesota:

SECTION 10. That all creameries before delivering to any patron any skimmed or separated milk shall have pasteurized the same at a temperature of at least 180° F.

Similar laws to the above are at present being considered for Wisconsin and Illinois, but have not as yet been enacted.



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A. D. MELVIN, CHIEF OF BUREAU.

THE CARE AND TESTING OF CAMEMBERT CHEESE.

BY

CHARLES THOM, PH. D.,
Assistant Dairyman, Dairy Division.

[Reprinted from the Twenty-fourth Annual Report of the Bureau of Animal Industry (1907).]



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THE CARE AND TESTING OF CAMEMBERT CHEESE.

By CHARLES THOM, Ph. D.,
Assistant Dairyman, Dairy Division.

This article is intended to aid in establishing a more general understanding of the following points with reference to the Camembert type of cheese:

1. The proper appearance of ripe Camembert cheese.
2. The variations in flavor among really good cheeses, corresponding to the widely different tastes of consumers.
3. How to test a cheese to determine its degree of ripeness without cutting it.
4. How cheeses not fully ripe should be handled by dealer and consumer to get the best results.

THE CHEESE DESCRIBED.

Camembert cheeses are made in sizes $2\frac{1}{2}$ to $4\frac{1}{2}$ inches in diameter and $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in thickness. They are ripened by the agency of molds and bacteria which form a feltlike rind over their whole surface one-sixteenth to one-eighth of an inch in thickness. This rind may be dry and gray or grayish-green, consisting of a feltlike surface of mold on the outside, below which a harder portion consists of mold embedded in partially dried cheese, or the moldy part may be more or less completely overgrown or displaced by yellowish to reddish slime composed mainly of bacteria. Good cheeses may have either appearance.

Inside the rind the cheese is softened progressively toward the center from all sides, so that a fully ripe cheese has no hard, sour curd in the center, but is completely softened. No mold should be visible inside the rind, but the moldy rind itself is necessary because the ripening is caused by the ferments secreted by the mold into the cheese. As the curd ripens the changed portion assumes a slightly deeper color than the unripe curd as a result of chemical changes. Well-ripened cheeses vary from nearly a fluid texture to the consistency of moderately soft butter.

DIFFERENTLY FLAVORED CHEESES.

Different brands of Camembert vary greatly in flavor when at their best. These differences have led to widely divergent ideals or tastes among consumers, and as a result to some contention as to which is

real Camembert. Investigation shows that slight differences in handling will cause large differences in texture and flavor in the same lot of cheese, hence all are equally entitled to be called Camembert. It is also possible to group together distinguishing marks which will enable the purchaser to select by examination such cheeses as will satisfy his particular taste. In general, intensity of flavor increases with the softness of the cheese; consequently very soft cheeses are usually strong cheeses. The firmer ripening is commonly associated with the milder and more delicate flavors. In surface appearance a sticky, slimy, yellowish rind betrays a tendency to strong flavors, while the dryer surfaces are generally a fair index to milder flavor. Although these signs sometimes fail in examining rapidly ripened domestic cheese, attention to them will give a large average of satisfaction.

HOW TO TEST RIPENESS.

The common practice of removing the box cover and pushing the index finger into the exposed surface of the cheese is not the best way for even an experienced judge to select a good cheese. The appearance of the cheese and its feeling to the finger may be sufficient after long practice, but the careful purchaser will find it far better to turn the box over, tap it gently so that the cheese will fall upon the free hand, then placing the thumb upon one side and the fingers upon the other, test by gentle pressure and a very slight shearing motion (one hand moved slightly toward or away from the body while the other is held stationary). Very little experience will enable one to detect whether a mass of unripe curd remains in the center, how large this is, if any, and the degree of softness in the fully ripe portion as indicated by firmness or tendency to lose shape in the hands. If a strong ammoniacal odor is present it indicates overripeness.

Unless the condition of the cheese is guaranteed by a reliable salesman the purchaser should examine each cheese carefully before buying. The consumer who wants a cheese exactly right will be amply repaid for the extra trouble.

CARE OF CAMEMBERT CHEESE.

Camembert cheeses are packed and shipped from the factory when half ripe or even earlier. This is especially true of imported cheese. In any case, after the cheese is packed for shipment transfer should be prompt. Crates should not be exposed to heat, dampness, or dryness. If the weather is warm, refrigeration in transit becomes necessary. If cheese must be stored in the warm season, refrigeration is indispensable.

As the imported cheese reaches our markets its ripening may often be finished by six to twenty-four hours in a warm room. Crates of

such cheese should not therefore stand in rooms as warm as 60° F. It has been a common but very bad practice to empty whole crates of cheese without reference to condition or ripeness upon the counter for the purchasers to pick from until all are sold. The purchaser of course takes his own risk, and usually gets a poor cheese. Such handling greatly hinders the trade in soft cheese.

To put trade upon a proper basis the condition of the cheese should be determined as soon as it is received. If already ripe, or nearly so, the whole lot belongs in the ice box. If still solid, the main stock should be kept in a cool cellar, 55° or below, and enough cheeses kept ripening in a warmer room to supply the trade from day to day. If the dealers would give the cheese the necessary care, based upon knowledge of its exact condition, as is the practice in the best hotels and restaurants, the percentage of satisfaction would be greatly increased. A cheese should not be offered for sale until it is fit to eat, and once sold it should be promptly served while in the best condition. Both dealer and consumer need therefore to base their treatment of Camembert cheese upon the same thoughtful care already given to other very perishable products.

The practice of the hotels and restaurants which serve this cheese regularly in perfect condition is comparatively simple. The cheeses are bought in quantity, and the condition of each consignment is promptly ascertained. The stock is stored, according to its condition—in the cellar or the ice box. A cheese nearly ripe is brought out and merely warmed for a few hours. If harder, the time in the warm room and even the temperature of the room is correspondingly increased, with careful watching. By keeping in this way enough cheeses just right to provide for the regular or expected trade, both dissatisfaction and losses are reduced to a minimum. One hotel serving cheeses in quarters at 25 cents a portion reports losses of less than 10 per cent on cheeses bought by the crate. This is much less than can be hoped for under less careful management, and such methods merit the consideration of all who deal in any way with Camembert cheese.

CANNED CAMEMBERT.

Among the forms in which Camembert cheese reaches the market are several brands of canned cheese. These have been partly or completely sterilized by heat, and the tins so far as examined have proved to contain fairly good flavored cheese. This treatment alters the flavor to some degree, but when successful preserves the cheese against time and changes of climate, making it available at any place or time of year. These brands command a limited but continuous market among those who can afford the increased price and who do not object to the flavor of cooking.

LABELS.

Domestic Camembert is now required to bear the legend "Camembert type" or "Camembert style," and to have designated upon it the State in which it is made. Only imported cheese is labeled Camembert without such modifying term.

Practically all Camembert cheese is made from milk from which a very little of the fat is taken. Labels reading "cream" or "double" or "triple" cream mean nothing beyond good cheese. Each brand and almost each cheese needs to be judged separately.

CAUTIONS.

Keeping.—If a cheese is already fully ripe, it should not be kept several days before eating. If it can not be eaten promptly, however, its tendency to quick decay can be checked (not entirely stopped) by putting it on ice and holding it there until nearly time to serve. Flavor and texture are then restored by permitting the cheese to thaw out at room temperature before serving.

Smell.—The proper odor of Camembert cheese is easily distinguished from the odors of decay, which are distinctly different. This odor may not be agreeable, but when properly discriminated from really objectionable odors it is no more disagreeable than that of fish or onions. If the cheese is really bad the odor becomes distinctly putrefactive.

Dried-up cheese.—A Camembert cheese shrunk from the side of the box or much depressed in the center is probably overripe or dried up by careless handling. A dried-up, powdery appearance of the rind with brownish or blackish areas indicates overripeness.

Bad ripening.—A yellowish to reddish, slimy surface, irregularly ridged and wrinkled, often conceals about one-fourth of an inch of liquefied, strong-flavored cheese over a hard, sour center, which refuses to ripen. This must not be confused with the smoother, reddish, slimy surface with faint parallel ridges, found upon certain excellent brands of cheese. Reddish, slimy cheeses should be carefully examined before buying.

Tin foil or paper wrapping.—Cheeses wrapped in tin foil incline to become soft and strong flavored; those wrapped in paper incline to the firmer textures and milder flavors. Cheeses wrapped in paper dry out so quickly when exposed that they must be watched more carefully than the others. They often become hard and gummy when old, hence are very deceptive.

Overripeness.—In addition to the marks already noted, overripe cheese always has a peculiarly sharp flavor readily recognized after eating once. Such a cheese showing no sour curd in the center is

often gummy or tallowy in texture and shows at times watery lines of cleavage between gummy masses.

Bargain Camembert.—Bargain-counter Camembert should be avoided unless the buyer is sure of his judgment as to the condition of the cheese. Cheeses sold at much reduction are almost sure to be either already unsalable at regular prices or so nearly so as to be very questionable. Some, however, enjoy cheese in various stages of over-ripeness, and such persons may safely buy the marked-down cheeses.

It should be remembered that there are few cheeses so good as good Camembert and few so bad as bad Camembert.

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BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 146.

A. D. MELVIN, CHIEF OF BUREAU.



FISHY FLAVOR IN BUTTER.

BY

L. A. ROGERS,
Bacteriologist, Dairy Division.



WASHINGTON:
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1909.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., March 11, 1909.

SIR: I have the honor to transmit herewith, and to recommend for publication as a circular of this Bureau, the manuscript of an article on "Fishy Flavor in Butter," by L. A. Rogers, of the Dairy Division.

Fishy flavor is a well-known depreciating factor in the butter trade of this country, particularly in certain sections, and has caused considerable losses. Its cause has been a mystery, and butter experts have been at a loss to account for its appearance. Since 1905 the Dairy Division has been working on the problem, and the investigations reported by Mr. Rogers in the accompanying paper throw considerable light on the subject. It is believed that his conclusions regarding the cause and prevention of the trouble will be of much practical value to butter producers.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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FISHY FLAVOR IN BUTTER.

INTRODUCTION.

Of the undesirable flavors of butter the various oily flavors may be classed as the most objectionable and troublesome. They range from a slight suggestion of an oil to a strong flavor of machine oil. In the latter case the inferior quality of the butter becomes evident even to the indifferent consumer. Fishy flavor, which is one of the most common of the oily flavors, gives to butter a peculiar oily taste suggesting mackerel or salmon. Butter is frequently described as fishy which is merely oily or otherwise off flavor, but the typical flavor of fishy butter is never mistaken for any other.

Although there are very few references to this subject in literature, the trouble is widely distributed. It is said that it has existed in Denmark, but that it has been almost entirely eliminated by improved methods and care in propagating starters.^a It is found in butter exported from Australia to England. It is known to occur in various parts of the United States, but is especially prevalent in the newer dairying sections of the Middle West. In one region this trouble occurs so frequently that it is spoken of among Chicago commission men as the "fishy belt." A large part of the butter made in the central creameries in which the cream is received in a sour or otherwise fermented condition develops fishy flavor if it is held in storage for any length of time.

There are many creameries where fishy flavor appears year after year. These creameries are not necessarily among those making poor butter or receiving overripe, hand-separator cream. On the contrary, a list of them would include many using the most approved machinery and methods and managed by competent butter makers.

Fishy flavor may develop in butter within a week or ten days after making, or it may not appear until the butter has been several months in storage. In the warm summer months butter is frequently fishy when it reaches the commission merchant. Sometimes this condition develops in one shipment alone, or in a few tubs in a shipment, but it is not uncommon for the trouble to persist in a creamery for days or even weeks. Outbreaks of this kind almost always occur during

^a Personal conversation with Dr. G. V. Ellbrecht, dairy councillor, Royal Agricultural Society of Denmark.

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or following warm weather. It is generally believed that fishy flavor is most common in hot, rainy seasons.

The most serious loss from fishy flavor is not caused by its appearance in fresh butter but in that held in cold storage. Low temperatures retard, but do not prevent, the development of this flavor. At 32° F. there is little retarding influence, but at 10° F. its appearance is perceptibly delayed. At 10° below zero the retardation is very marked, but even at this extremely low temperature butter may become fishy. Butter held in cold storage for several months without becoming fishy frequently becomes so after leaving storage before it can be sold by the retailer.

POSSIBLE CAUSES OF THE TROUBLE.

Many theories and hypotheses as to the cause of the trouble have been advanced, but most of them are unsupported by any experimental evidence. The immediate cause is generally ascribed to the presence of trimethylamin in the butter. This is frequently found among the decomposition products of many of the digesting bacteria, and can be produced in butter by the decomposition of casein or albumen.

The opinion has been held by butter dealers that fishy flavor was caused by certain brands of salt, and even now butter makers are sometimes advised to correct this fault by the use of a different salt. But a superficial examination of the conditions under which this trouble appears and of the factors which seem to control it excludes salt from the list of probable causes. It has also been suggested that ice, which in many creameries is added directly to the cream, may be the cause, but as fishy flavor sometimes develops in butter made from cream to which no ice has been added, this may be excluded as well.

It is within the range of possibility that the feed of the cows may have an influence by supplying some unusual constituents to the milk which by their decomposition give the fishy flavor to the butter. It is well known that the feed of cows has a decided influence on the taste of their milk, and while the resulting flavor ordinarily appears at once, this does not necessarily always follow, and the effect may not be evident until the milk has been made into cheese or butter.

It has been suggested that there may be a direct connection between the algæ commonly found in stagnant water and fishy flavor in butter.^a This theory is based on the fact that the fishy flavor of drinking water is caused by certain of the algæ, and it is further supported by the great abundance of stagnant water all through the "fishy belt" and the rapid increase of algæ in the warm wet weather which is commonly associated with outbreaks of fishy flavor in butter.

^a Piffard, H. G. New York Produce Review, vol. 13, No. 2, p. 20. New York, Nov. 13, 1901.

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O'Callaghan^a in New South Wales decided from his observations and investigations that this trouble was caused by the fungus *Oidium lactis*.

When the present investigation was started the most common and most probable hypothesis was that fishiness in butter was caused by bacteria, either by some particular variety or by some particular decomposition which could be brought about by any one of a number of species of bacteria. Assuming the immediate cause of the flavor to be trimethylamin, we would expect to find it produced by some bacterium or group of bacteria capable of growing in milk and cream in considerable numbers and producing there an enzyme which would decompose the casein of the butter even at the low temperatures of commercial cold storage.

INVESTIGATIONS TO DETERMINE THE CAUSE.

WORK WITH *OIDIUM LACTIS*.

O'Callaghan, as previously mentioned, asserts that he has demonstrated the immediate connection between this fungus and fishy flavor. In a later paper he states that he can always tell if butter will or will not become fishy by determining the presence or absence of *Oidium lactis*.^b His experiments are not given in detail. The writer, however, has been unable to produce by inoculations with *Oidium lactis* any flavor resembling fishiness, although three varieties purchased from Kral's laboratory were used in addition to a number isolated from domestic butter. This fungus is not very common in American butter and has never been found in more than very small numbers in samples of fishy butter examined by the writer. Furthermore, many lots of fishy butter have been made in which *Oidium lactis* was known not to occur either in the butter or in the cream from which the butter was made.

Oidium lactis may be the cause of what is known as "fishy flavor" in Australian butter, and it may even occasionally cause fishy flavor in American butter, but it is certain that it is not the common cause in this country.

WORK WITH CASEIN-DIGESTING BACTERIA.

During the first season in which the investigation of this trouble was systematically undertaken, bacteriological studies were made as thoroughly as the circumstances would permit of the cream in a number of creameries where there were outbreaks of fishy flavor. It was hoped to find in this way some form of bacteria common to all

^a O'Callaghan, M. A. Fishy-flavored butter, the cause and remedy. *Agricultural Gazette of New South Wales*, vol 12, pt. 3, pp. 341-346. Sydney, N. S. W., March, 1901.

^b O'Callaghan, M. A. Butter classification: The scientific examination of butter for export to England. *Agricultural Gazette of New South Wales*, vol. 18, pt. 3, pp. 223-227. Sydney, N. S. W., March, 2, 1907.

[Cfr. 146]

creameries having this trouble which would produce fishiness in controlled inoculation experiments.

In addition to the common lactic-acid type, two or three forms were found in large numbers in all the affected creameries. These were not new or uncommon varieties, but were always present in large numbers and were the only bacteria, excepting the lactic-acid group, sufficiently numerous to account for any unusual condition. One of these was *Bacterium lactis aerogenes*, which was always present in more than ordinary numbers, especially in the hand-separator cream. A second type was a coccus forming on gelatin small, round colonies surrounded by a clear, saucer-shaped liquefaction. Milk was curdled with an acid reaction and subsequent peptonization. This form was always present, frequently in large numbers, and grew readily in competition with the lactic-acid bacteria until considerable acid was developed. Other liquefiers occurred so irregularly and in such small numbers that they were not considered. One form characterized by its curious filamentous colonies was always found, but in small numbers only. However, inoculation experiments with these bacteria, either singly or in combination, gave only negative results, although they were repeated many times. Trimethylamin was separated in small quantities from milk cultures of the liquefying coccus, but it soon became evident that it had no direct connection with fishy flavor in butter.

It was found that large quantities of trimethylamin could be worked into butter without producing any trace of fishy flavor. Fishy butter was mixed with water made acid with sulphuric acid and distilled, and the distillate had a decided fishy odor and taste. The same flavor was found in the distillate from an alkaline solution. It is therefore evident that the fishy flavor of butter is not caused by anything of a basic or of an acid nature. These results exclude trimethylamin and suggest an aldehyde which could be produced in a great variety of decompositions and by many kinds of bacteria.

INVESTIGATION OF CONDITIONS ON FARMS.

In the second season's work an attempt was made to find one or more farms producing milk from which fishy butter could be made, so as to compare the conditions with those on farms where the trouble did not appear. In this way many of the complications unavoidable in a creamery could be eliminated, and it was hoped that a comparison of the bacteria, the flora of the pastures, and the general conditions would reveal something common to the fishy-flavor farms which did not exist on those producing normal butter.

A temporary laboratory was established at a creamery in Wisconsin where this trouble had been known to appear every summer for several years. Milk was taken from the patrons' cans at the intake and sepa-

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rated in a hand separator. The cream was allowed to ripen spontaneously and was churned in glass jars. The butter was packed in small glass jars and stored in the creamery refrigerator. By this method it was determined that the milk from certain farms made typical fishy butter on both the first and the second trial, while other farms were found producing milk which made butter with no abnormal flavor.

A thorough botanical survey of these farms was made by Mr. L. S. Cheney, whose long experience with the Wisconsin State geological and biological survey especially qualified him for this work. On account of its negative nature his report is not given. He found that no condition existed in the pastures and on the farms furnishing milk from which fishy butter was made which did not exist on some of the farms producing normal butter. This applied to the water supply as well as to the flora of the pastures. These results seem to exclude the possibility of any direct connection between the feed of the cows and the presence of the fishy flavor in the butter. We have, however, been unable by any combination of circumstances to produce fishiness in butter made under winter conditions. It is not unlikely that slight differences in the composition of the butter due to variations in the feed may account for this fact. This variation is evidently a general one and is not peculiar to localities where fishy flavor exists.

Bacteriological examinations of the mixed cream as it came from the separators at the creamery were made throughout the summer, and it was found that in a general way the variation in the bacterial flora of the cream was slight and was quantitative rather than qualitative. Although this creamery received no complaints of fishy flavor that season, fishy butter was made experimentally from the mixed cream, which was allowed to ripen spontaneously. The records of the bacteriological examinations showed no noticeable variation from the normal bacterial content at the time this butter was made.

Bacteriological examinations were made from the milk of farms producing milk from which fishy butter could be made, and the bacterial floras revealed by these examinations were compared with the bacterial flora of farms that furnished milk from which normal butter was made. It was evident from this work that there were no unusual varieties of bacteria connected with the production of the off flavor.

The possibility that this flavor might be produced by the development of bacteria not shown by ordinary culture methods is excluded by the results of an experiment made by Mr. C. E. Gray. In this work a starter was added to a lot of cream which had spontaneously overripened, and it was then pasteurized at 180° F. It is well established that practically all vegetable bacteria are killed at this temperature. The cream was cooled and churned at once, thus eliminating the possibility of any material development of bacteria after pasteurization. Before going into storage the butter was examined

and classed as fair butter, with no trace of fishy flavor. After four months in storage at -10° , 10° , and 32° F., it developed a very strong fishy flavor. Bacteriological checks were not made on this butter, but the growth of bacteria in butter stored from 20° to 40° below the freezing point is impossible, and the development of bacterial enzymes in the cream after pasteurization is highly improbable.

A more detailed study of the lactic-acid bacteria showed the presence of unusually active bacteria of this group in the milk from the fishy-flavor farms. Inoculation experiments were made, using bacteria isolated from the cream which made fishy-flavored butter. Cultures were used both singly and in various combinations. Butter made in this way frequently developed fishy flavor, but the results did not consistently connect that flavor with any particular variety or combinations of bacteria.

INFLUENCE OF ACIDITY.

An analysis of the records of all the inoculated butter which developed fishy flavor shows that this flavor always occurred in butter made with an active lactic-acid organism or in which a high degree of acidity had been developed with ordinary lactic-acid bacteria. Results obtained from butter made in other investigations and reported elsewhere^a throw light on this observation.

In Table 1 are given the results of butter made from one lot of cream to show the influence of varied degrees of acidity on the keeping quality of the butter.

TABLE 1.—*Results of experiments showing influence of varied degrees of acidity on the keeping quality of butter.*

Method.	Acidity of cream, ^b	Storage temperature of butter.	Condition after six months' storage.	Condition after nine months' storage.
<i>Unpasteurized.</i>	<i>Per cent.</i>	<i>° F.</i>		
No starter; no ripening.....		-10	Slightly rancid.....	Slightly bitter.
		10	do.....	Do.
		32	do.....	Rancid.
Starter added.....	0.45	-10	Slightly fishy.....	No fishy flavor.
		10	Trace of fishy flavor.....	Do.
		32	Fishy and oily.....	Fishy.
Ripened normally.....	.453	-10	No fishy flavor.....	No fishy flavor.
		10	Fishy (?).....	
		32	Fishy and oily.....	Tallowy.
Overripened.....	.473	-10	Slightly fishy (?).....	No fishy flavor.
		10	Slightly fishy.....	
		32	Very fishy.....	Oily and fishy.
<i>Pasteurized.</i>				
No starter; no ripening.....	.18	-10	No fishy flavor.....	No fishy flavor.
		10	do.....	Do.
		32	do.....	Do.
Starter added.....	.219	-10	No fishy or oily flavor.....	No fishy or oily flavor.
		10	do.....	Do.
		32	Fishy (?).....	Fishy (?).
Ripened normally.....		-10	Slightly fishy (?).....	Not fishy.
		10	Fishy (?).....	Fishy.
		32	Fishy.....	Fishy and rancid.
Overripened.....	.523	-10	Oily and fishy.....	Oily.
		10	do.....	Fishy and oily.
		32	Very fishy.....	Tallowy and fishy.

^a Bulletin 114, Bureau of Animal Industry (in press).

^b Acidity is expressed in this paper as per cent of lactic acid.

This table shows that the development of fishiness was clearly associated with the development of acidity in the cream. The fishy flavor was much more pronounced in the higher acid butters, especially in those stored at the higher temperatures. In the pasteurized cream butter, in which the acid was better controlled, the relation is evident. In the sweet-cream butter there was no trace of oily or fishy flavors. In the butter made with starter but without development of acid there was no trace of these flavors when stored at the lower temperatures, and only a doubtful appearance at 32° F. was found after nine months. In the ripened pasteurized butter there was a questionable fishiness in the butter stored at the lower temperatures and a distinct fishy flavor at 32° F. After nine months the fishy flavor had developed in the butter held at 10° F. The butter made from overripened cream showed a very pronounced fishy flavor after six months in storage regardless of the storage temperature.

A careful bacteriological examination had been made of the cream at various stages of the ripening, and of the butter before going into storage and at the end of six and nine months periods. At no time was there any development of bacteria other than of the lactic-acid group which could explain this change. Similar results have been obtained many times under varying conditions.

In all the experimental butter made in the last three years there has been no trace of fishy flavor in that made from pasteurized sweet cream churned without the addition of a starter. In butter made from pasteurized cream with starter added but without any subsequent ripening there has been no fishy flavor, with the possible exception of one or two doubtful cases. On the other hand, many lots of experimental butter made from well-ripened cream have developed a marked fishiness.

The relation of the acid to the fishy flavor has been demonstrated in butter made from pasteurized cream in which considerable acidity was developed by the addition of chemically pure acid. Table 2 shows the results obtained with two lots of butter made from pasteurized cream in which varying degrees of acidity were produced by the addition of pure acids. Bacteriological examinations of these creams showed only an insignificant development of bacteria. The butter was packed in sealed cans and stored for six months at 10° F., when it was examined by Mr. P. H. Kieffer. His comments show that a certain amount of acid is essential to the production of fishy flavor and that acids other than lactic will give this result.

[Cfr. 146]

TABLE 2.—*Fishy flavor in butter made from artificially acidified cream.*

No.	Cream acidified with—	Acid. <i>Per cent.</i>	Score.		Comments.
			Flavor.	Total.	
A 1	No acid.....	0.144	38	93	Fishy.
2	Lactic.....	.216	38	93	
3	do.....	.432	35	90	
B 1	No acid.....	.126	38	93	Do.
2	Acetic.....	.216	35	90	
3	do.....	.350	28	83	

It is evident, therefore, that there is a direct relation between the acidity of the cream and the development of fishy flavor in the butter. However, as the work progressed it became apparent that acidity, although having a determining influence on fishy flavor, was not its sole cause. With this factor controlled it was impossible to make butter with any certainty that it would become fishy. Frequently butter made from cream with a high acidity showed no trace of this flavor.

INFLUENCE OF OVERWORKING.

It has been said by butter dealers that fishy flavor is caused by a poor "body," or at least that the two are always associated. The statement has also been made to the writer that fishy flavor could be produced by overworking the butter.^a This opinion has been confirmed by results obtained in the course of this investigation. The following case is an illustration: Three tubs of butter made from one lot of cream were divided after five months in storage at 10° F., and one-half of each tub was badly overworked on a hand worker. Eighteen days later the butter was examined by a competent butter judge who knew nothing in regard to its treatment. His comments are given in the following table:

TABLE 3.—*Influence of overworking on storage butter.*

No.	Acidity.	Working.	Comments.
1	Starter added, not ripened.....	(a) Not worked..... (b) Overworked.....	Age. Oily, trifle rancid.
2	0.405 per cent.....	(a) Not worked..... (b) Overworked.....	Suggestion of fishy; fruity. Fishy.
3	0.585 per cent.....	(a) Not worked..... (b) Overworked.....	Age and acid. Badly fishy and age.

It will be noted that fishiness was observed only in a combination of high acid and overworking. This was also found to be true in butter made under more carefully controlled conditions.

In one experiment, to a lot of 33-per-cent cream pasteurized at 170° F. was added a starter in the form of a milk powder. The use of the powder made it possible to add a starter without increasing the initial acidity of the cream. After adding the starter the cream was divided, and portion 1 was cooled and churned. Portion 2 was allowed to ripen until the following morning. Portion 1 was churned at 48° F. and portion 2 at 49° F. The temperature of the buttermilk

^a Mr. H. J. Credicott, Dairy Division inspector at Chicago.

in each case was 55° F. After 20 revolutions with the rollers in gear, part of the butter was taken out and packed; the butter remaining was worked 20 more revolutions when another part was taken out; the remainder was worked an additional 40 revolutions. The butter (designated as Lot A) was examined when received in New York, eighteen days later, by Mr. Kieffer, who knew nothing of its history. Lot B was treated in a similar way but was made at a different time. The treatment of these butters and the comments of the scorer are given in the following table:

TABLE 4.—*Influence of overworking on flavor of butter.*

Lot.	Acidity of cream.	Revolutions worked.	Score.	Comments.
	<i>Per cent.</i>			
A 1.....	0.198	20	91	
		40	93	
		80	93	
A 2.....	.639	20	93	Mild and sweet.
		40	93	Do.
		80	90	Oily and fishy.
B 1.....	.252	20	92	Very mild in salt and flavor but sweet.
		40	92	Do.
		80	93	Do.
B 2.....	.694	20	90	Color mottled.
		40	93	
		80	89	Trifle oily and fishy.

In this butter also is found the same combination of high acid, overworking, and fishiness. The small churns used in these investigations rendered it necessary to churn at a low temperature and to work about 30 revolutions to make butter which would not show mottles. The butter worked 40 revolutions was therefore at most only slightly overworked. No comments were made by the scorers on the body of the butter worked 80 revolutions. This butter was packed in sealed cans bearing serial numbers only and stored at 10° F. After three months in storage one can from each lot was sent to each of three persons to score. Their comments and scores are given in Table 5:

TABLE 5.—*Scores of butter in Table 4 after three months' storage at 10° F.*

Lot.	Acidity.	Revolutions worked.	Score by F. R. B. Co.			Score by P. H. K.			Score by H. J. C.	
			Flavor.	Total.	Comments.	Flavor.	Total.	Comments.	Total.	Comments.
	<i>P. ct.</i>									
A 1	0.198	20	35	90	Old, unclean..	37	92	.....	88	Unclean and oily.
		40	36	91	do.....	37	92	.....	90	Do.
		80	39	94	Flat.....	38	93	.....	89	Do.
A 2	.639	20	30	85	Fishy.....	27	82	Very fishy...	85	Very fishy.
		40	30	85	Very fishy...	27	82	do.....	86	Do.
		80	30	85	do.....	27	82	do.....	85	Do.
		20	39	93½	Flat, trifle mottled.	38	93	.....	91	Very oily.
B 1	.252	40	39½	94	do.....	38	93	.....	91	Do.
		80	39	94	do.....	39	94	.....	91	Very oily, trifle unclean.
		20	30	84	Fishy, mottled	28	83	.....	85	Fishy.
B 2	.694	40	31	85½	do.....	32	87	Slightly fishy..	86	Fishy and oily.
		80	32	87	Stale dish-water and fishy.	30	85	Fishy.....	85	Fishy.

No trace of fishiness appeared in the low-acid butter, while all of the high-acid butter was more or less fishy. Overworking improved rather than impaired the flavor of the unripened cream butter, but evidently hastened the appearance of fishy flavor in the ripened cream butter. This deduction may meet with objection on the ground that the working produces only a physical change which can not affect chemical changes taking place weeks and even months later. However, consideration of well-known facts shows that the working is more complex than appears at first thought, and that by this process new factors may be introduced which can influence the subsequent changes. It is well established that when butter is worked in contact with water, especially at comparatively high temperatures, the water is thoroughly incorporated into the butter. If this process is properly controlled the incorporation is so complete that the water is not perceptible to the eye. Similarly, air is worked into butter in the ordinary process of working, and the whitening effect of overworking, which is easily demonstrated, is due to the air thus introduced. It is probable that this is not a bleaching but the physical effect of innumerable minute air bubbles. The whitening of a dark candy under the manipulation of a candy maker is a familiar example of this same effect. The fact that butter made by the usual methods contains air may be shown by putting a piece of butter in a jar of cold water and exhausting the air. Five or 6 cubic centimeters of air may be obtained in this way from 100 grams of butter. The exact amount of air contained in the butter could not be readily determined owing to the difficulty of separating the bubbles from the entangling mass of curd.

That the amount of air in butter is increased by overworking was demonstrated by adaptation of an apparatus used by Barcroft^a to determine the relative amount of oxygen in venous and arterial blood. The apparatus as used in this work consisted, as shown in figure 1, of a U-tube (*a a*) fastened on a support with a scale. The U-tube is filled to *c c* with mercury. The remainder of the tube is filled with water. Connected with each arm of the U-tube by rubber tubing are bottles (*b b*) of equal capacity, with rubber stoppers through which is passed glass tubing. The butter to be compared is weighed into the bottles. It is necessary to warm the butter to a semifluid condition in order to avoid the errors due to air held in mechanical holes. The flasks are then filled completely with an alkaline solution of pyrogalllic acid at 40° C. and the stopper put in place with precautions to avoid the retention of air bubbles. The stoppers are pressed in until the rubber tubes are filled and then wired securely in place. The tubes are then connected with the U-tube and so adjusted that the two columns of

^aBarcroft, Joseph. Differential method of blood-gas analysis. *Journal of Physiology*, vol. 37, No. 1, pp. 12-24. London, May 6, 1908.

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mercury are at the same level. The bottles are immersed in a water bath at 40°C . and shaken gently until the fat is thoroughly melted and all the oxygen and carbon dioxid absorbed. If the sample in one bottle contains more air than the other the reduction in pressure due

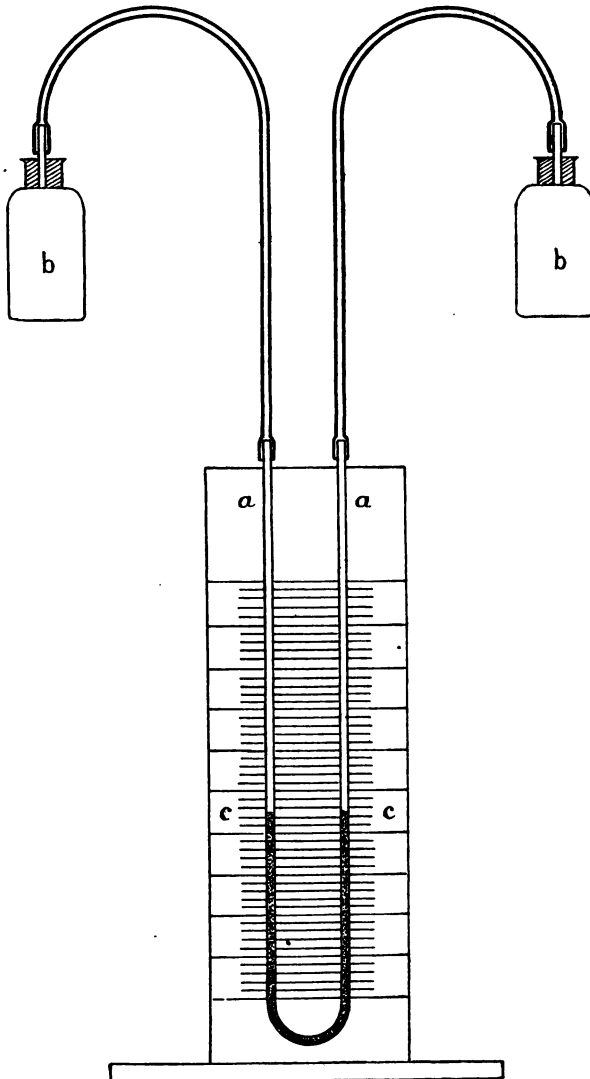


FIG. 1.—Apparatus used to determine relative amount of air in butter by absorption of oxygen.

to absorption of gases will be greater and the mercury will rise in the arm of the U-tube with which this flask is connected.

Butter badly overworked with a spatula always shows a distinctly higher oxygen content than an unworked portion of the same sample

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when they are compared by this method. The difference is usually equivalent to about 0.2 cubic centimeter of gas absorbable by alkaline pyrogalllic acid solution for every 10 grams of butter when measured under these conditions. This indicates an increased air content of over 10 per cent. With butter overworked in a churn the difference is small but distinct.

Similar results were obtained with an apparatus arranged as shown in figure 2. This consisted of a salt-mouthed, glass-stoppered bottle of 75 c. c. capacity, into which was sealed a tube of 6 mm. internal diameter and 1 meter long. This tube connected through the stopcock *f* and a U-bend with a bottle, *c*. The entire apparatus was securely clamped to rods and so arranged that it could be inclined for filling. It was tested to guard against leaks. In operating, the tube *b* was filled with mercury to the stopcock *f*, the stopcocks *e* and *f* were closed, and a definite weight of mercury was poured into the bottle *a*. The mercury filled the tube *bb* and about two-thirds of *a*. A tube holding about 20 grams of butter was filled with the butter to be tested and the sample forced by means of a plunger out of the tube into the bottle *a*. The stopper was then clamped in place and the stopcock *f* opened. The mercury flowed through the U-tube into the bottle *c*, where a constant level was maintained by the overflow tube *d*. The vacuum thus produced could be relieved by the stopcock *e*. Comparative tests were made consecutively and in a room in which the temperature was constant within narrow limits; the error due to variation in barometric pressure and temperature could therefore be ignored. The volume of the sample, the volume of air remaining in the bottle *a*, and the vapor tension were constants. The only varying factor, then, which could be expected to influence the height of the mercury column would be the air contained in the butter.

The results with butter overworked with a spatula are as follows:

TABLE 6.—Results of tests showing amount of air in normal and overworked butter.

		Mercury column.	Average.
		Millimeters.	Millimeters.
<i>Sample tube No. 1.</i>			
Normal.....		650	647
Do.....		640	
Do.....		650	
Overworked.....		634	633
Do.....		612	
Do.....		644	
Do.....		644	
Difference.....			14
<i>Sample tube No. 2.</i>			
Normal.....		644	644
Do.....		644	
Overworked.....		619	
Do.....		628	624
Difference.....			20

This method indicated that the overworked butter contained more air than the unworked portion of the same butter, although the normal

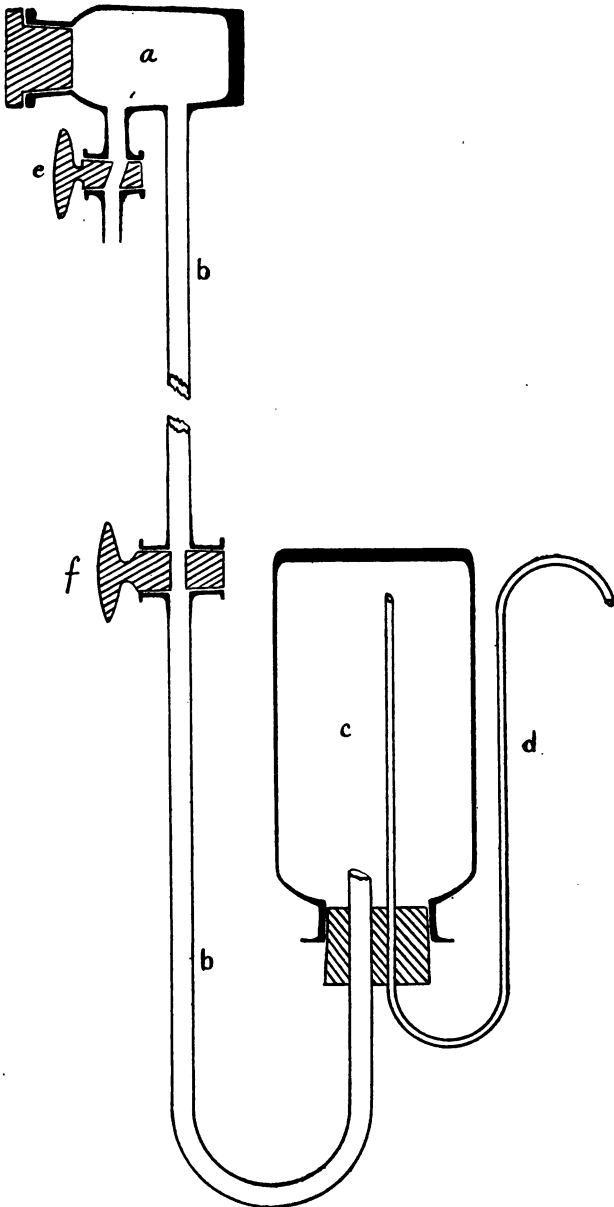


FIG. 2.—Apparatus used to determine relative amount of air in butter by differences in vacuum.

butter contained numerous mechanical openings which were removed by the working. The overworked portion was homogeneous without

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visible cracks or bubbles. Overworking not only increases the actual amount of air in butter, but obviously decreases the size of the bubbles and thus increases the area of butter exposed to the action of the air. If the amount of air in a given sample of butter remains constant and the diameter of the bubbles is reduced one-half, the surface area of the bubbles will be doubled and the rate of oxidation correspondingly increased.

CONCLUSIONS.

Fishy flavor in butter is evidently not produced by the action of any one special factor. The results given in this paper indicate that its immediate cause is a particular substance produced by the oxidation of one of the combinations of the acid developed in the ripening of the cream. The substance oxidized may be the result of a hydrolysis of one of the constituents of the butter by the acid. In the ordinary ripening sufficient acid is produced to make the development of fishy flavor possible. If the cream is overripe and a corresponding high acidity is present the appearance of this flavor is much more probable. Air is probably always present in quantities sufficient to produce fishiness, other factors being favorable, but the development of this flavor is hastened and made more certain by overworking, which increases the air and the oxidizing surface. It is true that in many cases fishiness is not observed in butter made from high-acid cream. This may be because the particular acid combination is not present or because the fishiness is masked by other objectionable flavors usually found in high-acid butter. It is probable also that in the course of the decomposition of the butter the substance producing the fishy flavor is further oxidized or otherwise changed so that the fishiness disappears.

Fishy flavor, however, is not infrequently reported in butter in which its occurrence could not be explained on this basis. Different scorers have different conceptions of what is included under this term, and many lots of butter are scored fishy which could not be called fishy as the term is used in this paper. This varied use of the term has resulted in some confusion in this and in other investigations, and it has been necessary to exclude results in which there was a difference of opinion and to depend largely on those scorers whom experience has shown to be most consistent and conservative in their judgment.

The deductions drawn from these investigations are in accord with all the facts which are known in regard to this trouble. In newer dairy sections where fishy flavor is common, barns and milk houses are less likely to be well constructed, and there is more probability that the milk comes to the creamery heavily inoculated with acid-forming bacteria. This is especially true of the central creameries, where the cream is usually received in a very acid condition. It is

also true that in hot weather, when fishy flavor is most common, cream is more likely to become overripe and to be churned at a high temperature and consequently overworked.

In Denmark the trouble is less prevalent than formerly, and this has probably been brought about, not by greater care in the selection of starters, but by making a mild-flavored butter from pasteurized cream ripened to a low degree of acidity. The presence of *Oidium lactis* in Australian butter may be considered, not as the cause of fishiness, but merely as an indication that the butter was made from high-acid cream, a condition which is well known especially to favor the growth of this organism.

The practical application of the work herein outlined is evident. The butter maker who receives whole milk or fresh sweet cream can prevent the appearance of this trouble with certainty. High-grade butter with a low acidity may be made by adding a good starter to pasteurized cream and churning without ripening, or the pasteurized cream may be churned sweet without the addition of any starter. In creameries receiving hand-separator cream in which the acid is well developed the problem is more difficult, and under such conditions it may be impossible to control this trouble. The amount of working the butter receives is almost entirely under the control of the butter maker. The working necessary depends on various factors, but in any case overworking should be avoided. In this the butter maker may have to choose between a low moisture content and the possible depreciation in price on account of fishy flavor.

GENERAL SUMMARY.

Flavor.—Fishy butter has the peculiar oily flavor of mackerel or salmon.

Geographical distribution.—The trouble is of widespread occurrence, but is most noticeable in newer dairy sections.

Seasonal appearance.—Fishy flavor rarely or never appears in butter made in the cold months and is most likely to appear in fresh butter during a period of hot weather. The trouble may be noticeable in one shipment only, or it may continue to be observed for days and even weeks.

Appearance in storage butter.—It may occur in butter a few days after making, but usually does not appear until the butter has been held in storage. Low temperatures retard but do not prevent the development of fishy flavor.

Oidium lactis.—Contrary to the results reported by O'Callaghan, fishy flavor could not be produced by inoculation with *Oidium lactis*.

Bacteria.—No species or group of bacteria could be found peculiar to creameries having trouble with fishy flavor. Inoculation experi-
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ments with bacteria occurring in these creameries failed to connect the trouble with any one kind, and daily bacteriological examinations of the mixed cream in a large creamery failed to show any noticeable variation in the bacterial flora at times when fishy butter was made.

Fishy-flavor farms.—By making butter in small lots from many farms it was possible to find farms producing milk from which fishy butter could be made by allowing the cream to ripen spontaneously. Botanical surveys of these farms showed nothing which could differentiate them from other farms producing butter which did not develop fishy flavor. Bacteriologically, the only peculiarity of the cream from these farms was the presence of very active lactic-acid bacteria.

High-acid cream.—In all cases in which the records were complete it was found that those experimental butters which became fishy were made from high-acid cream. Fishy butter was made from cream acidified with lactic and acetic acids. However, cream with high acidity does not uniformly develop fishiness.

Overworking.—Fishy flavor may be produced with reasonable certainty by overworking the butter made from sour cream.

Cause.—In the opinion of the writer, fishy flavor is caused by a slow, spontaneous, chemical change to which acid is essential and which is favored by the presence of small amounts of oxygen.

Prevention.—Fishy flavor may be prevented with certainty by making butter from pasteurized sweet cream. Butter made from pasteurized sweet cream with a starter but without ripening seldom if ever becomes fishy.

ACKNOWLEDGMENTS.

The writer wishes to express his appreciation of the assistance rendered by many creamery managers, butter makers, and butter dealers, whose cooperation has made this investigation possible. He is also under obligations to his former colleague, Mr. C. E. Gray, and many others, for assistance and valuable suggestions.

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Issued June 16, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 147.

A. D. MELVIN, CHIEF OF BUREAU.

THE ORIGIN OF THE RECENT OUTBREAK
OF FOOT-AND-MOUTH DISEASE
IN THE UNITED STATES.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., April 24, 1909.

SIR: I have the honor to transmit herewith and to recommend for publication as a circular of this Bureau a report by Dr. John R. Mohler, chief of the Pathological Division of this Bureau, and Dr. Milton J. Rosenau, director of the Hygienic Laboratory of the United States Public Health and Marine-Hospital Service, of an investigation into the origin of the recent outbreak of foot-and-mouth disease in the United States.

On November 10, 1908, this disease was discovered among cattle in Pennsylvania, and a few days later it was found also in Michigan, New York, and Maryland. In view of the strict quarantine maintained by the Bureau on imported live stock and the fact that the importation of ruminants from countries where foot-and-mouth disease existed was prohibited entirely, it seemed highly improbable that the infection was brought in with animals, and various other ways in which it might have gained entrance into the United States were suggested, as that immigrants carried the virus on their clothing, that it was brought in on hay or straw used for packing, or that it was introduced in biological products. When, therefore, the disease was traced by the Bureau's inspectors to calves that had been used in propagating smallpox vaccine by a Detroit establishment, and the cases of longest standing were found among these calves, it was considered probable that the vaccine was contaminated with the virus of foot-and-mouth disease and that this caused the outbreak, especially since vaccine had been suspected of being responsible for the New England outbreaks of 1902-3.

When suspicion was thus directed to the vaccine virus of the Detroit establishment it was decided to make an investigation to determine this point; and as the United States Public Health and Marine-Hospital Service of the Treasury Department is charged by law with the supervision of biological products used in human medicine, that Service was requested to join this Bureau in making the proposed investigation. The work was confided to Doctors Mohler and Rosenau, and the results are given in the report herewith presented.

It is evident from their tests, which were carried out in accordance with careful scientific methods, that the recent outbreak of foot-and-mouth disease was caused by the propagation of vaccine virus which had been contaminated with the virus of foot-and-mouth disease, and that the contaminated strain of vaccine originally came from some foreign country where the disease prevailed. In some of their tests Doctors Mohler and Rosenau used animals which had been vaccinated and were therefore immune to vaccinia or cowpox, so that, in case the infection of foot-and-mouth disease was present in the vaccine under suspicion, the lesions of that disease would not be suppressed or obscured by those of vaccinia. By this method and by means of intravenous inoculation they were able to detect the contaminating infection when it might not otherwise have been disclosed. In the light of the evidence obtained as to the origin of the recent outbreak it now seems probable that the New England outbreaks of 1902-3 were due to the same cause.

Although the foot-and-mouth disease has been eradicated after vigorous work by this Department and Bureau in cooperation with the State authorities, the facts disclosed by this report show that the country is in constant danger of having this and other contagious diseases of live stock introduced from abroad in spite of all the precautions that the Department is able to take under existing legislation. The United States Public Health and Marine-Hospital Service already has power, under the act of Congress of June 1, 1902, to control the importation of biological products used in the prevention or treatment of diseases of man, and I consider it highly important that similar control should be given by law to the Secretary of Agriculture over similar products when intended for the treatment of domestic animals.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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THE ORIGIN OF THE RECENT OUTBREAK OF FOOT-AND-MOUTH DISEASE IN THE UNITED STATES.

NATURE AND CHARACTERISTICS OF THE DISEASE.

Foot-and-mouth disease, also known as apthous fever, epizootic apthia, and *eczema contagiosa*, is an acute, highly communicable disease chiefly confined to cloven-footed animals and characterized by an eruption of vesicles on the mucous membrane of the mouth and on the skin between the toes and above the hoofs. The vesicles rupture, forming erosions and ulcerations; there is also salivation, tenderness of the affected parts, loss of appetite, lameness, emaciation, and diminution in the quantity of milk secreted.

The tremendous ravages of the disease are seen in the number and variety of the species attacked. While it may be regarded as essentially a disease of cattle, hogs would seem to be as easy a prey. Almost in the same grade of receptivity are sheep and goats. Next in order of susceptibility come the buffalo, American bison, camel, chamois, llama, giraffe, and antelope. Horses, dogs, cats, and even poultry, may occasionally become infected with the disease, the last three being particularly dangerous as carriers of the contagion. Man himself is not immune, and the frequency of his infection by coming in contact with diseased animals is established by numerous observations.

The disease prevails in European countries and occasions great economic losses. The mortality is quite low, the serious losses depending chiefly upon the diminution of the milk secretion and the loss of flesh in the affected animals.

Foot-and-mouth disease has made its appearance in the United States only on five different occasions—1870, 1880, 1884, 1902–3, and 1908. Its spread is very rapid among cattle, owing to the highly communicable character of the contagion, but fortunately every outbreak upon American soil has thus far been quickly followed by its complete suppression.

The causative agent of this disease has not been isolated, although numerous attempts have been made to cultivate and stain it. The experiments of Loeffler and Froesch in 1898 have shown that the virus will pass through the finest porcelain filters, thus indicating its

ultramicroscopic size and the reason it has not been detected by staining methods.

The specific principle may be found in the serum of the vesicles in the mouth and on the feet and udder; in the saliva, milk, and various secretions and excretions; also in the blood during the rise of the temperature. Animals may be infected directly, as by licking, and in calves by sucking, or indirectly by fomites such as infected manure, hay, utensils, drinking troughs, railway cars, animal markets, barnyards, and pastures.

No definite immunity is rendered by an attack. The period of incubation is variable, usually from two to six days. The disease may appear in twenty-four hours after exposure. In exceptional instances the period of incubation is prolonged to fifteen or even eighteen days.

FOOT-AND-MOUTH DISEASE IN MAN.

Foot-and-mouth disease is primarily and principally a disease of cattle; secondarily and casually, a disease of man. The disease is transmissible to man through the ingestion of raw milk, buttermilk, butter, cheese, and whey from animals suffering from foot-and-mouth disease. It is also transmitted directly, though more rarely, from the salivary secretions or other infected material which may gain entrance through the mucous membrane of the mouth. It is doubtful whether the disease can be transmitted to man by cutaneous or subcutaneous inoculation, though it is probable that the infection may be communicated if the virus directly enters the blood through wounds of any kind. Children are not infrequently infected by drinking unboiled milk during the periods in which the disease is prevalent in the neighborhood, while persons in charge of diseased animals may become infected through contact with the diseased parts or by milking, slaughtering, or caring for the animals.

The symptoms in man resemble those observed in animals. There is fever, sometimes vomiting, painful swallowing, heat and dryness of the mouth, followed by an eruption of vesicles on the buccal mucous membrane and very rarely by similar ones on the fingers. The vesicles appear on the lips, gums, cheek, and edge of the tongue, and are about the size of a pea. The vesicles soon rupture, leaving a small erosion which is soon covered by a thin crust under which the new formation of epithelium proceeds rapidly. The skin eruption mostly appears on the hands, tips of the fingers, base of the nails, volar surfaces of the finger tips, and more seldom on the toes and other parts of the body. Besides these local changes, during the course of the disease there are occasionally observed headache, pain in the limbs, vertigo, abdominal cramps, vomiting, diarrhea, and weakness. The disease is very seldom fatal, usually appearing in a very mild form

except in weakened children, in whom an accompanying intestinal catarrh may lead to a fatal termination.

Veterinarians who have had considerable experience with the disease among animals regard the human affection as by no means uncommon in countries where foot-and-mouth disease prevails, but the disturbance of health is usually too slight to come to the notice of the family physician.

Valentin was probably the first to suggest the infectiousness of milk and the transmissibility of the virus to man through the milk of diseased animals. He reported several cases where people became infected during the outbreak in Hesse in 1695. Sagar in 1765 reported a similar infection of men in Moravia from drinking infected milk. In 1778 all the residents of an Austrian monastery developed a vesicular eruption in the mouth after drinking infected milk.

Hertwig, Mann, and Villain conducted an experiment on themselves in 1834 by drinking milk warm from a cow suffering with an attack of foot-and-mouth disease. Five days later vesicles appeared on the hands, fingers, tongue, cheeks, and lips of Hertwig, while the eruption in the other two was confined to the buccal mucous membrane.

Allbutt observed the vesicular eruption in the mouths of three children in Yorkshire during the English outbreak in 1883, and obtained information of a number of similar cases in the community.

During the 1883 outbreak in Germany a shepherd apparently infected himself by holding in his mouth a knife which had just been used in paring the diseased feet of his sheep. During this outbreak a number of milkmaids were infected through milking, the vesicles appearing principally on their hands.

In the Berlin outbreak of 1895 a number of those who drank infected milk developed fever, followed by the formation of vesicles on the tongue and lips. The acute disease lasted about five days, leaving a feeling of weakness for some time. Virchow made an investigation of these cases and unhesitatingly pronounced the affection to be foot-and-mouth disease.

A collection of the cases of this disease transmitted to man through the consumption of milk has been prepared by Wurzburg, while the work of Bussenius and Siegel contains a full bibliography of the literature of such transmissions up to 1896.

Instances resulting from the use of butter made from infected milk are on record, while Schneider mentions instances where human infection followed the consumption of infected cheese. Friedberger and Fröhner record cases which were caused by infected buttermilk.

But few outbreaks of the disease have occurred in the United States, and therefore cases of its transmission to man in this country

are quite rare. Law reports having observed the disease in man from drinking infected milk during the epizootic of 1870 in the Eastern States, but the outbreaks of 1880 and 1884 affected such a small number of animals and were so quickly suppressed that no instance of its transmission to man was recorded. A few cases have been reported by Brush ^a accompanying the New England outbreak of 1902. Similar reports have been likewise received concerning the appearance of vesicular eruptions in the mouths of children during the 1908 outbreak, and the history of these cases incriminates the milk supply.

Experiments by Loeffler and Froesch, ^b as well as recent experiments which have been made in Denmark and Germany, indicate that the infection is comparatively easy to destroy by heat or the usual antiseptics. Milk pasteurized at a temperature of 60° C. for twenty minutes is safe so far as infection by foot-and-mouth disease is concerned.

HISTORY OF RECENT OUTBREAKS.

On October 26, 1908, two carloads of cattle infected with or exposed to foot-and-mouth disease were sent from the stock yards at East Buffalo, N. Y., to Watsontown and Danville, Pa., respectively, from which points the disease was distributed to nine separate farms. It was upon these farms that the disease was brought to the attention of Dr. Leonard Pearson, State veterinarian of Pennsylvania, who in turn notified the United States Department of Agriculture on November 10, and the diagnosis was confirmed on November 11 by Dr. A. D. Melvin, Chief of the Bureau of Animal Industry, and Drs. Rice P. Steddom and John R. Mohler, chiefs, respectively, of the Inspection and Pathological divisions of the Bureau.

An endeavor was at once made to trace the disease from the affected cattle back to the point of origin, but at that time it was impossible to obtain any definite clew regarding the source of the infection which would lead beyond the Buffalo stock yards. The only information which seemed at all significant was the fact that five bulls in the carload lot which went to Watsontown and two bulls in the car which went to Danville originated in the shipment of Mr. J. Jackson, living in the central portion of the State of Michigan. In order that this clew should be run down as quickly as possible, an inspector was at once detailed to look up the origin of this shipment, while other inspectors at the same time were sent to points in Canada, Ohio, New York, and Indiana for the purpose of investigating the condition of the cattle remaining at the farms where originated the

^a Journal of the American Medical Association, vol. 40, June 20, 1902, p. 1700.

^b Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, 1. abt., vol. 23, 1898, p. 371.

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balance of the cattle in the two carload lots which went to Watson-town and Danville from Buffalo. Reports from all these inspectors were duly received and proved to be entirely negative.

Subsequently (on November 22) a suggestive telegram was received from the Bureau of Animal Industry's inspector in charge at Detroit, Mich., and another telegram was received from a local veterinarian in the same city stating that a mild type of foot-and-mouth disease was prevailing on several farms in that vicinity. This diagnosis was confirmed on the following day, and it developed that among the animals infected with foot-and-mouth disease were 21 heifers which had previously been used by Manufacturer A for the production of vaccine virus. This fact caused Secretary of Agriculture James Wilson and Doctor Melvin, both of whom had gone to Detroit to make a personal investigation of the outbreak, to suspect the contamination of the vaccine material used; and inasmuch as the United States Public Health and Marine-Hospital Service, under the act of Congress of July 1, 1902, is charged with the supervision of biological products used in the prevention and treatment of diseases of man, the Secretary requested the cooperation of that Service in an investigation, which was carried out by the writers of this paper. The character of the lesions in the mouths and on the feet of the above-mentioned animals indicated that they were in the fourth stage of the disease, or the stage of healing, and that these lesions were older and more nearly healed than those found in any other center where the infection had been observed.

For these reasons, together with the fact that the outbreaks of foot-and-mouth disease in 1902 and 1903 were quite closely associated with the vaccinated cattle of the New England Vaccine Company's establishment and Dr. E. E. Tyzzer's experimental work with vaccine at a farm at Wakefield, Mass., it was deemed advisable to make a thorough investigation of the movements of the 21 vaccinated cattle above referred to, and to ascertain if possible what connection, if any, the use of these cattle for the production of vaccine virus by Manufacturer A had with the origin of the 1908 outbreak of foot-and-mouth disease.

The outbreak of foot-and-mouth disease in Massachusetts during 1902 started in Chelsea, and the place where it was thought to have originated was the farm of Mr. Owen Clark, who had a contract with Doctor C., of the New England Vaccine Company, to rent calves for the propagation of vaccine virus. These calves were later returned to Mr. Clark after the vaccine virus had been secured. Doctor C. occasionally obtained seed vaccine from outside sources to either strengthen or improve his product. He admitted having obtained a foreign strain, presumably of Japanese origin, through Manufacturer

B, during the summer of 1902, while the outbreak in Mr. Clark's herd occurred in August of the same year. Although suspicion was directed to this source of origin of the 1902 outbreak, it was finally concluded that, as Mr. Clark's place was so near to Massachusetts Bay and the docks, there was some likelihood of the contagion having reached his farm through infected hay, straw, fodder, or other material from the trans-Atlantic steamers, and this explanation was quite generally accepted in lieu of more definite evidence.

Later an independent outbreak of foot-and-mouth disease was started at Wakefield, Mass., in August, 1903, by Dr. E. E. Tyzzer, of Harvard Medical School, who was doing some experimental work in the study of vaccine bodies. He inoculated some calves on his father's farm with seed vaccine obtained from Doctor K. It was said that this virus also came from Japan, through Manufacturer B. As a result foot-and-mouth disease developed not only in the inoculated calves, but in the milch cows on the farm as well. The State of Massachusetts and the Bureau of Animal Industry subsequently had Doctor Tyzzer repeat the experiments at an isolated stable in Wakefield that was rented for the purpose, and foot-and-mouth disease was again produced in this second series of inoculated cattle by the use of the same sample of vaccine virus.

There is no question that Tyzzer succeeded in producing foot-and-mouth disease as a result of inoculation of vaccine virus which in some way had become contaminated with the virus of foot-and-mouth disease, and in his report to Doctor Salmon, then Chief of the Bureau of Animal Industry, he wrote:

The mouth lesions and the vesicles occurring on the udders of the experimental animals presented a special type of necrosis and represent a process entirely distinct from vaccinia. * * * Two cows having passed through the eruptive disease described in this report were not immune to vaccinia, as has been shown by the inoculation of vaccine lymph and the subsequent microscopical study of the lesions.

Drs. U. G. Houck and G. A. Johnson, who had been designated by the Bureau of Animal Industry to make clinical notes on these cases, state in their report that "the vaccine lymph used on both herds was responsible for the conditions that developed in them; that is, the production of a contagious disease, which, if it is not foot-and-mouth disease, the symptoms and lesions defy a differential diagnosis."

However, there have always been an element of doubt and some contention with reference to the manner in which this vaccine became contaminated. The possibility that this vaccine virus, which had been removed from its original container, was contaminated by placing it in an ice chest with specimens of foot-and-mouth disease at once suggested itself to Doctor Salmon. This, however, does not seem at all certain, particularly in the light of our present knowledge,
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although this view was apparently strengthened by the fact that four different series of experiments conducted at that time with vaccine obtained from the original source failed to produce any lesions recognized by the investigators as due to foot-and-mouth disease. The coincidence of having this outbreak occur in the quarantined section only two or three months after the last cases of the previous outbreak had been eradicated threw further doubt upon the contamination of the vaccine virus.

With these facts in mind, and with the knowledge that the 21 vaccinated cattle of Manufacturer A were among the first to show foot-and-mouth disease in the present outbreak, the writers proceeded to the laboratories of this manufacturer, arriving November 30, 1908. The movements of these cattle were at once investigated, with the result shown in figure 1.

These cattle were purchased in September by Shaw Brothers, who had a contract with Manufacturer A to furnish the animals for vaccination purposes. After they had been vaccinated and the vaccine pulp removed, the cattle, as was the custom, were returned to Shaw Brothers, who received a rental price for each animal and subsequently disposed of them to the public. In this particular instance the animals were vaccinated on September 23 and October 6, and turned back to Shaw Brothers October 16, on which date they were driven to the Haley Commission Company's pens in the Detroit stock yards, watered and fed for two hours, and then taken to a town 15 miles distant, where they were dispersed. The appearance of foot-and-mouth disease was observed on October 18 by Mr. I. W. Shaw, who purchased 10 of these animals, and by other purchasers about the same time.

In obtaining a record of all shipments that subsequently passed through the pens of the Haley Commission Company, which presumably became infected by the 21 vaccinated cattle, it was quite interesting to learn that the healthy cattle, previously referred to as having been collected by Mr. J. Jackson, were shipped to the Haley Commission Company on October 20 and all but 32 sold. The latter animals were reshipped to East Buffalo on October 23 and evidently carried the contagion from the infected pens of the Haley Commission Company to the Buffalo yards, and thence by means of the 7 bulls in the consignment to Watsontown and Danville, Pa., as already mentioned. All subsequent centers of infection have been directly or indirectly traced to the 21 vaccinated animals as the original source of infection. All other shipments which passed through the Haley Commission Company's pens for six days previous to the receipt of the vaccinated cattle have been traced to their destinations with negative results, while negative results have also followed the investiga-

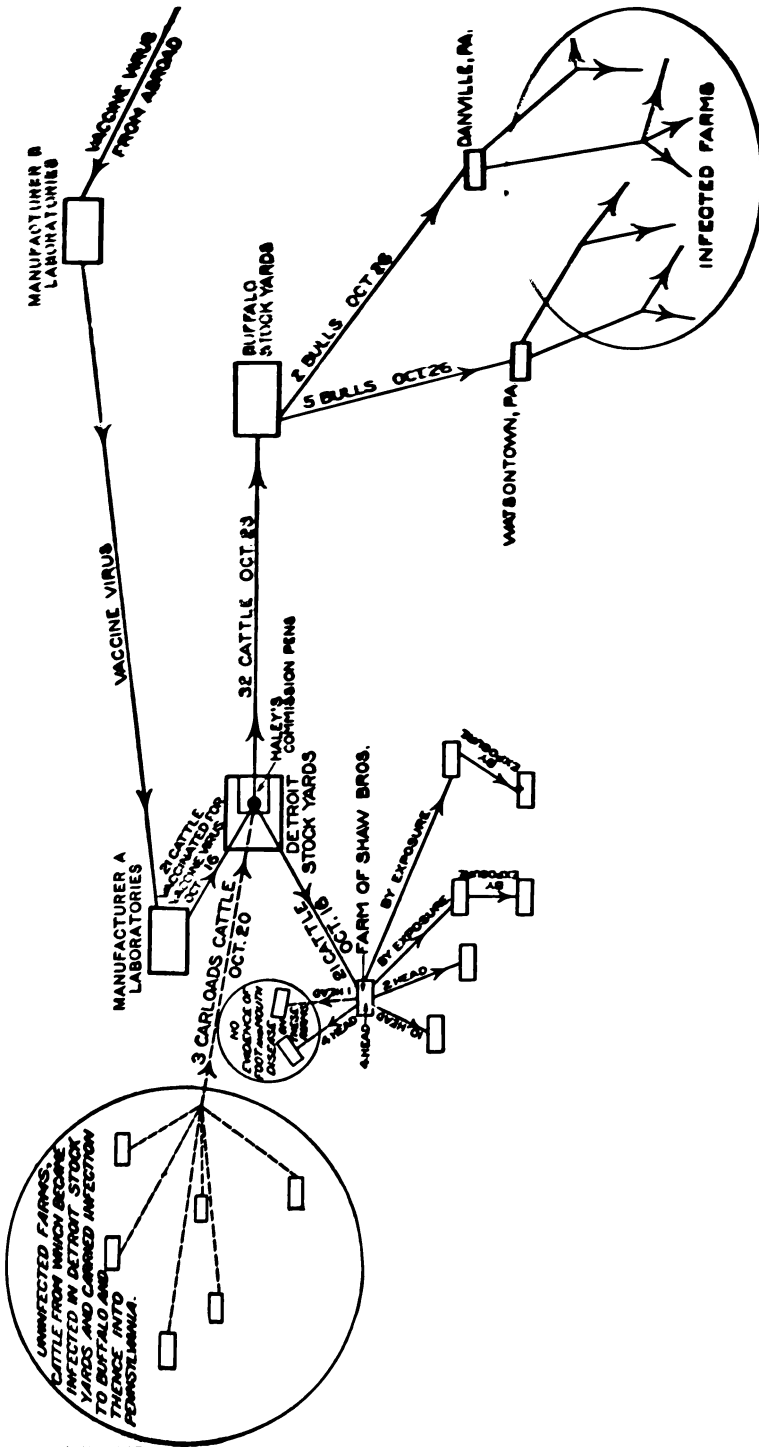


FIG. 1.—Diagram showing how infection of foot-and-mouth disease was spread.

Manufacturer B imported certain vaccine virus which was contaminated with foot-and-mouth disease, and Manufacturer A procured some of it's vaccine of this strain. Calves used by A in propagating vaccine, some of which were afterwards found to be infected with foot and mouth disease, were sent to the Detroit stock yards and thence to certain farms near Detroit. Four days later three carloads of cattle from central Michigan reached the Detroit stock yards and were put into the pens previously occupied by the vaccine calves. Some were sold for slaughter at Detroit and the remainder were shipped to Buffalo. Nine were reshipped to Danville and Watontown, Pa., where the disease was first observed. The disease spread to various places in Pennsylvania and New York and to one locality in Maryland.

tion of places whence these 21 cattle came before they were taken to the vaccine stables of Manufacturer A.

The likelihood of the infection of these cattle through vaccination at the latter's plant having been indicated, three separate strains of vaccine virus which had been used by the firm during 1908 were secured. The experiments performed with these three lots of vaccine virus are here briefly recorded.

EXPERIMENTS WITH VACCINE VIRUS.

FIRST SERIES OF EXPERIMENTS.

These experiments with seed vaccines obtained from Manufacturer A were made jointly by the writers of this paper, assisted by Dr. E. C. Schroeder and Mr. W. E. Cotton, of the Bureau of Animal Industry, at the Bureau's Experiment Station, Bethesda, Md. A cement stable was erected for the purpose of making these tests, and special care was at all times maintained to prevent any experimental error. One attendant, who had never seen foot-and-mouth disease, and had not recently been employed among cattle or other live stock, was transferred to the work of caring for these experiment animals. All animals were kept under observation continuously for at least two weeks before the experiments were made, and in all cases the mouths and feet were carefully examined before injections were made. The three strains of vaccine virus tested in this series of experiments were obtained from Manufacturer A by the writers during a joint visit and were kept in possession of one of them (Rosenau) until the package was broken and the vials opened immediately before use. The entire work was carried out in a careful manner and every effort made to prevent outside contamination.

The clinical notes are as follows:

Calf 625.—This heifer calf, about 3 months old, was inoculated December 14, 1908, by scarifying the skin of the abdomen in three different areas, one area being inoculated with each of the strains of virus obtained from Manufacturer A and known respectively as the J strain, the D strain, and the Manufacturer B strain. This calf, which had not been previously used for producing vaccine virus, developed typical vesicles and pustules of cowpox, but did not show any indications of foot-and-mouth disease.

Three other heifer calves, Nos. 675, 676, and 674, about 5 weeks old, were inoculated intravenously December 14, 1908, with the J strain, the D strain, and the Manufacturer B strain, respectively. These animals were obtained from a local vaccine manufacturer, and having been used for the propagation of vaccine virus were immune to cowpox. Calves 675 and 676, inoculated with the J and D virus, remained healthy and failed to show any indication of disease following their injection. On the other hand, calf 674, which had been inoculated similarly with the Manufacturer B strain, developed lesions of foot-and-mouth disease as recorded in the following:

Calf 674.—December 14: Injected intravenously in right jugular vein with 2 c. c. of Manufacturer B's vaccine.

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December 26: No indication of foot-and-mouth disease.

December 28: A small papule with a gray center about 2 mm. in diameter is noted on the gum of the upper jaw just above dental pad. This is the third papule of this character to make its appearance, the first being on the outside of the lower lip just at its margin, and the second inside the lower lip. All four feet from ankle down somewhat swollen and reddened.

December 29: Papule noted above has broken and left only a small eroded area. A fresh one is forming on gum of lower jaw. Swelling of feet has subsided, except in the left hind one, which is also much reduced.

3.30 p. m.: The papule noted above now has a small gray center.

December 30: The papule found yesterday appears to-day as a small erosion. Interdigital space of left hind foot reddened, other feet normal.

January 2, 1909: Two small vesicles have developed and broken on right side of tongue; one new one forming on right side of inner lower lip. Vesicles have formed and broken in interdigital space of both hind feet.

January 4: One small erosion, covered by an ulcerating surface on outside of lower lip near its margin. Lesions on side of tongue noted January 2 have disappeared. Lesions in interdigital spaces are commencing to heal.

January 7: One new hyperemic patch about 3 mm. in diameter is forming on inside of lower lip.

January 8: Lesion noted yesterday is now fairly well developed and has a gray necrotic center. One reddened papule in interdental space on right side of lower jaw.

January 18: A number of small superficial erosions, more or less circular in outline, on under side of tongue. At the peripheries of each there is a narrow zone of very thin brown epithelium, which is loosened from the basement membrane.

January 19: Erosions present on under side of tongue yesterday have partially coalesced. There are three similar circular areas on dorsum of tongue, from which the superficial layer of the mucous membrane has been eroded, leaving the papillæ still intact.

The temperature, taken twice daily since date of inoculation, has never exceeded 39.7° C.

January 20: The desquamated areas on the tongue have coalesced and increased in size. Killed. Head and left hind foot preserved as specimens.

The interesting feature in this case was the subsidence of the primary lesions and the subsequent recurrence of active erosions.

Calf 656.—December 29, 1908: Injected intravenously in right jugular vein with saliva and material from papule which had formed on gum of calf 674, mixed with sterile salt solution.

December 30, 9 a. m.: Nothing abnormal. 3.30 p. m.: A number of red papules have formed on the hard palate.

December 31: A few more slightly raised reddened areas with gray centers have developed on upper lip.

January 2, 1909: The lesions have not progressed to any further stage of development and are gradually fading away.

January 4: No lesions. The highest temperature recorded was 39.4° C.

January 9: Killed and buried immediately without autopsy.

Calf 654.—An area scarified on inside of lower lip and one on gum corresponding to it were inoculated December 29, 1908, with material scraped from papule which had formed on gum of calf 674. On the fourth day a considerable number of reddened papules formed on inside of lower and upper lips and on hard palate. Similar hyperemic zones were noted on the gums of the lower

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jaw on the sixth day. These showed a dry grayish center on the following day, which on being removed left a small eroded surface without any fluid being visible. Other lesions of a similar character appeared at irregular intervals on the mucous membrane of the gums, lips, and hard palate until January 11, after which all the remaining lesions gradually disappeared. The highest temperature observed was 39.6° C. On January 20 the calf was killed and the head preserved.

Calf 623.—Inner side of lower lip scarified and inoculated January 2, 1909, with scrapings from lesions on lip of calf 654. On the fourth day several small circular areas, each covered by a gray scab, had formed at seat of scarification. These scabs disappeared on the following day, leaving small eroded areas. On the sixth day a large eroded area appeared on the dental pad and hard palate which soon became eroded and covered by a thin brownish exudate. This area increased in size on the following day coincidentally with the appearance of reddened papules on the gums, interdental space, and inside of lower lip. Similar lesions continued to appear at irregular intervals until January 23, when one or more large reddened patches were noted on nearly every transverse ridge of the hard palate. On January 25 the epithelium over these areas began to erode, the color gradually fading. Several small desquamated areas and two shallow erosions appeared on the gums behind the incisors and in the interdental space respectively. The highest temperature observed was 39.3° C. Animal killed February 27.

Cow 333.—The right side of inner surface of lower lip scarified and inoculated January 9 with material scraped from lesion in mouth of calf 623. On the second day a few small erosions partially covered with scabs appeared within area of scarification. By the fourth day several new red circular lesions of the usual character had formed within and contiguous to area of scarification. On the following day about 15 small circular erosions with gray necrotic centers were noted within and contiguous to the area of scarification. Five days later several small reddened patches appeared on the inside of the lower lip and the gums below the incisors.

January 20, injected into left jugular a small quantity of material from mouths of calves 674 and 654, which was mixed with 4 c. c. sterile salt solution. Several small reddened areas on hard palate appeared January 23. Two days later one shallow circular erosion about 8 mm. in diameter developed on gum of lower jaw. On the following day three small reddened patches with eroded centers were noted on hard palate; the small erosion still present on gum of upper jaw. About the same condition was observed three days later except that the lesions last noted were gradually disappearing. Highest temperature recorded was 39.1° C. Animal killed and buried February 11.

Calf 677.—February 5: Inside of lower lip scarified and inoculated with scrapings from the lesions of calf 623 and cow 333.

February 9: A considerable number of small, very superficial erosions within the scarified area; one a short distance outside, and another on opposite side of lower lip.

February 10: On the upper surface of tongue there are three circular areas about 3 cm. in diameter where the epithelium has become desquamated. On under side of tongue there are also two small eroded areas.

February 11: A considerable number of small red papules with small gray centers within and surrounding the seat of scarification, some of them being a considerable distance removed. On dorsum of tongue there are a number of circular and elliptical areas where the epithelium has become eroded, leaving

the papillæ and basement membrane intact. On inferior and lateral surfaces there are a number of similar raw surfaces, in some of which a narrow rim of desquamated epithelium remains attached to the periphery. The saliva is unusually thick and viscid. One small irregular erosion about the size of a bean is noted in the cleft of the left hind foot.

February 12: Many of the lesions on dorsum of tongue have coalesced; fully two-thirds of the epithelium has been desquamated. The lesions on sides and under surface of tongue have increased in size. There are a considerable number of red papules on gums of upper jaw, in the interdental space of lower jaw, and on the hard palate. The lesion in the interdigital space of the left hind foot shows no change.

February 13: Nearly all the epithelium has been stripped from the tongue. Many papules still present on inside of lip and on gums and a few new ones on hard palate. One small eroded lesion in interdigital space of each hind foot.

February 15: The epithelium of the tongue which has been exfoliated is now replaced by new tissue, leaving the tongue again normal with the exception of a small erosion on the inferior surface. There are several papules on hard palate and on inner side of lower lip. The lesions in interdigital spaces of hind feet have about disappeared.

February 16: Many red patches with eroded centers on hard palate. A few on both upper and lower lips. The highest temperature that has been recorded was 39.6° C.

March 6: No lesions apparent. On this date cow 375, occupying a corner stall in the same stable with this calf (677), was inoculated intravenously with material from the mouth of calf 609, which had been injected with vaccine from Manufacturer B.

March 11: Calf 677 has an erosion about 15 by 30 mm. on dorsum and right side of tongue and a similar one about 5 mm. in diameter a short distance in front of the other. Morning temperature, 40.3° C.; afternoon, 40° C.

March 12: The smaller area noted yesterday has increased to about 15 mm. in diameter. The longer one is about the same size as it was yesterday. Both are coated with a brownish-yellow exudate. Three additional erosions have appeared on dorsum and left side of tongue, each from 10 to 15 mm. in diameter. Three erosions, each about 12 mm. in diameter, have made their appearance on anterior portion of dental pad and upper lip near median line, and have coalesced, fragments of the desquamated epithelium being still present. Near by, on the upper lip, a vesicle about 1 cm. in diameter broke while the animal was being examined. The vesicle was very flat and appeared to be simply a circular white area in which the epithelium had become separated from the basement membrane. The amount of serum present, if any, was so small as to escape observation. On the inside of the lower lip there is a very shallow erosion about 3 mm. in diameter. No lesions on feet.

March 13: The lesions on the tongue have commenced to heal. A new eroded area has made its appearance on the buccal membrane, just back of the first molar tooth, left side. Killed at 4 p. m. A small whitish area, apparently a vesicle just forming, was found after death in the interdigital space of one of the fore feet. The head and foot was preserved in Kaiserling's fluid.

This case is particularly interesting on account of the recurrence of the lesions as a result either of autoinfection or of exposure to cow 375, which suffered from a more severe form of the disease.

Cow 375.—February 11: Moved into infected stable where the previously mentioned cases were kept to receive natural exposure to foot-and-mouth disease.

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February 11 to March 5: No lesions.

March 6, 4 p. m.: Injected intravenously with 5 c. c. of an emulsion of desquamated mucous membrane from calf 609 (see third series of experiments), which contracted foot-and-mouth disease as a result of the inoculation of Manufacturer B's vaccine.

March 10: Yesterday afternoon animal refused to eat; the flow of saliva was increased. This morning she has an erosion fully 2 cm. in diameter on side of lower lip; there is a second one about 1½ cm. in diameter on buccal membrane, immediately back of the right commissure of lips. There are also several small erosions in this region and a few on opposite side of mouth. The tongue is very sensitive and a vesicle is forming at its tip. Considerable drooling from the mouth; also clear discharge from nostrils. No lesions on feet. Animal eats very little. The temperature yesterday morning was 38.4° C.; afternoon, 39.6° C., while this morning it was 38.7° C., and remained about this height until the animal was killed (March 13). Yesterday afternoon's temperature was the highest observed during the experiment.

March 11: Large amount of rosy saliva drooling from the mouth. The two large erosions noted yesterday, which were then very red, raw-looking surfaces, are now coated with a thin grayish lymph. The several small erosions noted then have increased in size and are coated with the same kind of an exudate. Several large, white, circular vesicles have made their appearance on the dental pad. The epithelium of the entire tip of the tongue has disappeared, leaving a large raw surface. The right front foot has large vesicles filled with serum at both the front and rear of interdigital space and on bulbs of heel. The right hind foot is in a similar condition, with the exception that the vesicles have broken and serum can be pressed out of them. The left hind foot is in much the same condition as the right hind one. The left fore foot is also similarly affected, but not to the same degree as the others.

March 12: Lesions in the mouth much the same as yesterday, excepting that the white circular vesicles on the pad are now raw surfaces, the loosened epithelium having disappeared. Two additional large erosions which have coalesced found on dorsum of tongue. The vesicles on feet have nearly all broken, leaving raw and eroded surfaces partly covered by the desquamated epidermis. The animal is very lame. There is still considerable drooling from mouth.

March 13: The earlier lesions in mouth and on tip of tongue are beginning to heal. The feet are very sore, large raw surfaces being present within and behind and in front of the interdigital spaces. In some places the desquamated epidermis is still attached. Killed at 4 p. m. The head and all four feet preserved.

Cow 630.—March 10, 4 p. m.: Moved to infected stable and placed between cow 375 and calf 677 as a cohabitation experiment.

March 15: An elevated vesicle about 15 mm. in diameter has formed on left side of tongue. It has broken (10 a. m.), leaving a small opening in the center, and the desquamated epithelium is still attached at the periphery of lesion. No other lesions. The highest temperature recorded was 38.8° C., which occurred this afternoon, while the morning temperature was 38.3° C.

March 16: The epithelium is completely eroded from the area noted on tongue yesterday. The right side of upper lip is thickened, and what appears to be a spherical vesicle 2 cm. in diameter is forming and nearly ready to break on the mucous surface. On the inner surface of opposite side of the lip there is a flat vesicle about 12 mm. in diameter. On the end of tongue a slightly raised vesicle fully 2 cm. in diameter is noted. If a little pressure is exerted

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in this region blood oozes from the fungiform papillæ within the affected area. There is some drooling. Animal eats fairly well. A small area within interdigital space of left front foot seems sensitive, but no lesions yet visible. Killed at 3.30 p. m. Head and left foot, the latter showing two small vesicles in interdigital space, preserved.

Calf 614.—March 13: Moved to infected stable for a natural exposure experiment after cow 375 and calf 677 had been killed. It was placed as far away from where these animals had stood as the inclosure would permit.

March 15: One erosion about 1 cm. in diameter and two raised white vesicles, each about 5 mm. in diameter, on dorsum of tongue. Two small, very fresh erosions on gums of lower jaw below the incisors.

March 16: The white vesicular elevations noted yesterday as being on the dorsum of the tongue are now erosions 15 mm. or more in diameter; the one to the right of the median line has become confluent with an erosion noted yesterday, leaving a raw surface, $1\frac{1}{2}$ by 3 cm. in diameter. Still another erosion, 1 cm. in diameter, has appeared on the dorsum of the tongue. There are now three erosions, each about 15 mm. in diameter, on gums of lower jaw below the incisors, and another 10 by 15 mm. inside of the lower lip, 2 cm. from median line. A very sensitive spot is noted within the interdigital space of the left fore foot. At 3.30 p. m.: A large amount of clear viscid fluid is being discharged from nose and mouth. It is so viscid that it hangs down in long strings from each side of the mouth. Killed. Head and left fore foot preserved. A vesicle was beginning to form on the inner side of one of the bulbs of the heel of left fore foot. The highest temperature recorded for this animal was 39.5° C., which occurred this morning.

It should be noted that in the last two instances, cow 630 and calf 614, foot-and-mouth disease obtained from vaccine virus was transmitted by natural modes of infection.

During the course of this series of experiments ample opportunity had been offered for the disease to spread to susceptible animals which cohabited with the inoculated cattle. This, however, did not occur until the introduction of the virus from calf 609 (third series of experiments) into cow 375 on March 6, where it assumed such an exalted virulence that cow 630 and calf 614 readily contracted the disease by natural exposure. For instance, calf 675 was kept in the foot-and-mouth-disease stable from December 14 until it was slaughtered on January 20; calves 676 and 625 were likewise kept in this stable from December 14 until January 9; cow 173 from January 20 to February 27; cow 375 from February 11 to March 5; hog 2449 from February 11 to February 27; sheep 34 from February 11 to February 27, and two male lambs from February 20 to March 11, but without presenting any lesions of foot-and-mouth disease. The only explanation that appears tenable for this absence of natural transmission of the disease is that the virus had become greatly attenuated, probably as a result of its admixture with vaccine virus, and it required passage through a particularly susceptible individual before it became exalted in virulence.

This same lack of virulence was observed in the disease as it occurred at the beginning of the recent outbreak. Five of the twenty-
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one vaccinated calves of Manufacturer A were taken to two farms, and although they were permitted to commingle with the cattle on these farms continuously, no occurrence of the disease at these places took place. On the other hand, foot-and-mouth disease developed on every farm where the remaining sixteen cattle were taken.

In order that vaccinia (cowpox) could definitely be eliminated in making a diagnosis of the disease being produced by vaccine virus, it was thought desirable in addition to using vaccinated calves (immune to cowpox) to check the work further by inoculating guinea pigs on the scrotum and rabbits on the cornea with scrapings from the lesions produced in the calves. This was done by one of us (Mohler) in the first five cases, and the work was duplicated by the other (Rosenau) in three of the cases with entirely negative results.

It will be recalled that of the three strains of vaccine obtained from Manufacturer A, the only strain which proved to be contaminated with foot-and-mouth disease virus was obtained from Manufacturer B, and the records showed that this virus was received by Manufacturer A in May, 1908. In order to ascertain if this latter vaccine was contaminated at the time of its propagation, the establishment of Manufacturer B was visited and seed vaccine from five different lots was obtained for inoculation into sheep and calves, which experiments will be described below.

SECOND SERIES OF EXPERIMENTS.

The establishment of Manufacturer B was visited by the writers on February 1 and 2, and the records of the various vaccine seeds were examined, especially as to their origin and the character of lesions produced in the vaccinated calves. Five different lots of vaccine were obtained and experiments were at once started with a particular virus, for convenience termed "vaccine V." This strain was the same as that which had been procured by Manufacturer A. About 10 c. c. of this vaccine virus was obtained in a glass pipette, both ends of which were sealed in a flame, and the material was kept in the possession of one of us (Mohler) until used.

Sheep were used for this experiment, and they were kept in one of the animal rooms in the new laboratory building of the Department of Agriculture, where no experiments in foot-and-mouth disease had been conducted. These animals, with one exception, had been raised at the Bureau Experiment Station, and all had been under close observation for at least three weeks before the inoculations were made. This series of experiments was conducted personally by Doctor Mohler assisted by Doctor Eichhorn and an attendant who had not seen foot-and-mouth disease and had not been in any place near the infected districts. Before the pipette containing the vaccine was

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opened it was submerged first in a 5 per cent solution of carbolic acid and then in 95 per cent alcohol. A small quantity of the contents was then emptied into a sterile crucible and 1 c. c. drawn up into a syringe which had just been sterilized. Every possible precaution was observed in order to prevent any outside contamination and to be able to connect definitely with the vaccine under investigation any positive results which might be obtained.

Sheep 1.—This animal was born at the Experiment Station and was about two years old. It had been vaccinated with uncontaminated vaccine virus during January and was therefore immune to vaccinia.

February 5: Injected intravenously in right jugular with 1 c. c. of Manufacturer B's vaccine V.

February 6: Temperature 39.0° C. Appetite good. No lesions.

February 7: Temperature 40.5° C. Appetite fickle. No lesions.

February 8: Temperature 40.6° C. Refuses its feed. Has been lying down since 8 a. m., when the attendant arrived. At 9 a. m. the sheep is made to rise but holds left fore foot off the ground, flexing it rapidly, apparently from pain. On walking lameness is shown in this foot and there is considerable heat noted above the coronet. On examining the interdigital space of this foot two elongated vesicles are observed, one on each claw, raising the epiderm of the soft skin, just above its attachment to the horn. On pulling the toes farther apart both vesicles ruptured, liberating a clear, watery serum. No mouth lesions.

February 9: Temperature 41.9° C. Both fore feet show erosions which extend from the anterior to the posterior border of the interdigital space, involving principally the soft skin adjacent to the coronary band. Animal is quite lame in these feet and also in the left hind foot. The latter is also found to contain an eroded elongated patch at the juncture of the skin with the horn of the hoof, and a small pea-sized vesicle is just forming in the posterior part of the cleft. No lesions in the mouth. Killed at 4 p. m. and three legs preserved. Blood defibrinated and injected into sheep 2.

Sheep 2.—February 9: This animal, a western sheep which had been under observation for 6 weeks, was injected intravenously in right jugular with 1 c. c. of filtrate of blood from sheep 1.

February 10: Temperature 39.1° C. No lesions.

February 11: Temperature 39.5° C. No lesions.

February 12: Temperature 40.1° C. The first indication of disease outside of the temperature and fickle appetite is noted to-day in that the animal is quite lame in the right front foot. On examination a small vesicle about the size of a kidney bean is observed in the front part of the cleft between the digits, while there is a hyperemic zone around the outside border of the coronet. The mouth and other feet appear normal.

February 13: Temperature 39.3° C. The vesicle which was observed in the cleft of the right front foot yesterday has ruptured and an irregular erosion with reddened base and partly covered around the borders by necrotic epiderm has taken its place. Several minute vesicles are noted above the coronary band on the outside claw, while above the heel of this claw is a moist erosion, evidently the result of a recently ruptured vesicle. No other lesions apparent, although the mouth and other feet were carefully examined. Killed at 3 p. m. Material was obtained from the vesicles and erosions for inoculation of sheep 3.

(It should be noted here that some of the filtrate obtained from sheep 1 was also injected intravenously into a cow and a Bardados sheep, but without producing any lesions. The injections of these latter cases, however, were not

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made until February 11, forty-eight hours after the filtrate had been obtained, during which interval it was kept in a refrigerator.)

Sheep 3.—This animal was a yearling born at the Experiment Station and kept under close observation since January 1. Like sheep 1, it had been made immune to vaccinia by cutaneous scarification and inoculation of normal vaccine virus.

February 13: Injected intravenously in right jugular vein with 1 c. c. of fluid prepared by adding physiological salt solution to the material obtained from lesions in sheep 2.

February 14: Temperature 39.1° C. Apparently normal.

February 15: Temperature 41° C. Animal lying down most of the day. Appetite capricious. Quite sensitive if pressure is applied to cleft of left front and right hind foot.

February 16: Temperature 40.9° C. Sheep is very lame in front and particularly so in right hind leg, which is scarcely placed on the ground in walking. On examination this foot is seen to have a vesicle the size of a marrow-fat bean in the fold of skin in front of and between the digits above the interdigital space. Two erosions which are still moist and partly covered by denuded epiderm appear in the posterior part of the cleft and involving both heels. Blood is slowing oozing from the eroded surface. The left fore foot has an erosion on each claw running along the soft skin immediately above the horn of the hoof, very similar to the lesion described in the same foot of sheep 1. The right front foot shows a hyperemic area which is quite sensitive directly in the middle of the interdigital space. A small flat vesicle about the size of a split pea is forming on the glome of the inside digit. Directly in front of this on the outside coronet is a small eroded patch irregular in outline, which is covered with a grayish exudate of lymph. A marked erythema is noted above the coronary band of both digits of this foot. No mouth lesion. Animal killed at 4 p. m. Two legs preserved.

During this series of experiments sheep 4 and lamb 5 were continuously exposed to the infected sheep 1, 2, and 3, eating of the same hay, and frequently from the same feed box, but in neither case was the disease transmitted by such cohabitation. It should also be stated in passing that material from the vesicles and erosion in each of the infected sheep was rubbed well into scarified areas on the scrotum of a guinea pig and applied to the slightly abraded cornea of a rabbit, but in no case were lesions of vaccinia produced.

THIRD SERIES OF EXPERIMENTS.

This series of tests was made independently by one of us (Rosenau) in the Hygienic Laboratory, United States Public Health and Marine-Hospital Service.

The rooms in which the experiments were carried on were just finished in a new wing of the building, and had never been used for any other purpose. The inoculations were made personally by Doctor Rosenau, assisted by Doctor Frost. The care of the animals was intrusted to two janitors. None of the persons mentioned had been near any case of foot-and-mouth disease, nor had any of them had any association with cattle or sheep.

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The animals used in this series were four young calves which had previously been used by a local manufacturer for the propagation of vaccine virus. They were obtained from a district entirely free from foot-and-mouth infection. They were under continuous observation for twenty days before the experiments were attempted.

The two strains of vaccine virus used in this series of experiments were personally obtained by one of us (Rosenau), who made independent trips to the establishments of Manufacturers A and B partly for this purpose, in order that there might be no connection or contamination with the virus used in the other experiments. Each strain of virus was obtained in a carefully sealed package and not opened until the moment of use. Before opening the vials they were immersed in bichlorid of mercury solution (1 to 500) in order to eliminate any outside contamination. In short, every possible precaution was taken to guard against all sources of experimental error.

Four calves, immune to vaccinia, were given an intravenous injection of the virus. The protocols are as follows:

Calf 609.—Black female, about 4 weeks old. Vaccinated, February 13. All incisions showed typical vesicles. Vaccine material taken February 19.

March 1 injected intravenously with 2 c. c. of glycerinated vaccine virus V of Manufacturer B.

On the fourth day vesicles appeared on dorsum of tongue, followed by desquamation of epithellium, leaving a large, sharply defined, and typical punched-out ulcer with deep reddened base, papillæ intact, and containing a small island of intact mucous membrane. In addition there were a few other smaller vesicles containing clear fluid. Salivation; no foot lesions; temperature rose to 39° C.; marked weakness. Animal killed on fifth day. Tongue preserved.

Calf 611.—Red male, about 5 or 6 weeks old. Vaccinated February 13. Typical take along all incisions. Vaccine material taken February 19.

March 1 given intravenous injection of 2 c. c. glycerinated vaccine virus V of Manufacturer B.

Forty-eight hours later three dark red congested macules appeared on ventral surface of tongue, two of which disappeared about twenty-four hours later; the third formed a vesicle, which ruptured within two days, leaving a superficial erosion which rapidly healed. During this time there were excessive secretion of viscid saliva and slight reddening of the margin of gums. Temperature rose to 39.6° C. on second day.

On the eighth day a small vesicle appeared on inside of upper lip, and inside of left cheek a papilla denuded of mucous membrane was noted, also three small red spots on the hard palate which continued till the animal was killed.

On the tenth day another erosion appeared on upper lip and tip of tongue.

Coincident with first appearance of these mouth lesions a small erosion appeared in the interdigital space of left hind foot, evidently a ruptured vesicle. By the eighth day the skin of the whole interdigital space of this foot was white, soft, necrotic, and perforated in several places with irregular small ulcers with reddened bases. In a corresponding position on the right hind foot appeared on the fourth day also several reddened spots and erosions.

On the ninth day a large vesicle appeared, occupying practically the whole of the interdigital space of the left fore foot, which ruptured and exuded a clear sanious fluid.

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Killed on the tenth day. Specimens preserved.

Calf 610.—Red-and-white female, about four weeks old. Vaccinated February 13. All incisions showed typical vesicles. Vaccine material scraped February 19.

March 1, inoculated intravenously with 4 c. c. glycerinated vaccine virus which Manufacturer A obtained from Manufacturer B.

On the second day two small papules developed on margin of tongue, which disappeared on the fourth day. Margin of gums reddened and a small superficial erosion developed on gums near central incisor teeth. On hard palate posteriorly appeared three large reddened maculæ. Centers of each spot became grayish and necrotic. Other similar patches subsequently developed on the pharynx.

An eczematous condition developed around anterior margin of interdigital clefts of both hind feet on second day, with subsequent formation of minute vesicles which quickly dried. In interdigital space of left hind foot a small vesicle appeared on the sixth day, which broke, forming an erosion which rapidly healed.

Killed on the tenth day.

Calf 612.—Red-and-white female, about five or six weeks old. Vaccinated February 13. Gave good take, all incisions showing typical vesicles, which were removed February 19.

March 1, injected intravenously with 4 c. c. glycerinated vaccine virus which Manufacturer A procured from Manufacturer B.

About the seventh day, redness of margins of gums, salivation. Small ulcer on dental pad. Small superficial ulcers on gum anteriorly and one in angle of mouth. Mucous membrane of pharynx red and congested. Mild eczematous condition of skin about interdigital cleft; no vesicles. Killed on the tenth day.

Diagnosis.—Calves 609 and 611 had typical clinical pictures of foot-and-mouth disease. The diagnosis was confirmed by Doctors Melvin, Mohler, Bennett, Elchhorn, Formad, Ditewig, and several others, who saw the animals after the lesions were well advanced.

It is believed that calves 610 and 612 also had foot-and-mouth disease of a benign type.

RESULTS SHOW CONTAMINATION OF VACCINE VIRUS.

It must appear evident from the clinical notes presented in the above three series of experiments that the vaccine virus propagated by Manufacturer B in April and May, 1908, was contaminated with the virus of foot-and-mouth disease. The history of this particular vaccine shows that it was a Japanese strain, imported for the purpose of improving the standard of vaccine produced by that company. The fact that the foot-and-mouth infection was present in the vaccine virus of Manufacturer B for so long a period, but was not transmitted to outside cattle, was doubtless due in part to this firm's practice of killing its calves after taking the vaccine virus. Manufacturer A, on the other hand, rented his calves and placed them again on the market a short time after the vaccine material was taken. In this way the disease spread from the vaccine stables of Manufacturer A, but not from those of Manufacturer B, although it was the vaccine virus from the latter establishment that infected the former's cattle.

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DIFFERENTIAL DIAGNOSIS.

The clinical picture presented by the first few animals of the first series of experiments and two of the animals in the third series of experiments was somewhat confusing at first, as the disease appeared in such a benign form and the lesions were far from being typical, and further appeared at rather irregular intervals over a number of successive days rather than within a relatively short and definite period of time. We have no explanation to make of this except the fact that we were at first working with a decidedly attenuated virus of the disease. While a mistake might be made in these early cases because of the slow infection of the animal, the failure to transmit the disease by cohabitation, the presence of suggestive though atypical lesions, the absence of the characteristic vesicles and foot lesions in some of the cases, and the very conspicuous absence of general symptoms, especially drooling, inappetence, high temperature, and great loss of flesh, still such lesions as were observed must in the light of our present knowledge be considered as highly suggestive of foot-and-mouth disease.

The lesions, however, which occurred in calves 609 and 611 of the third series of experiments, sheep 1, 2, and 3 of the second series, and cows 375 and 630 and calves 677 and 614 of the first series were so entirely typical and the symptoms manifested in some of these animals were so true to the natural disease that in these cases there was no question of the diagnosis, and it so happened that three or more of these cases were observed and the diagnosis confirmed by Doctors Melvin, McEachran, Law, Pearson, White, Schroeder, Bennett, Hickman, Washburn, Eichhorn, Ditewig, Formad, and several others who have had experience with foot-and-mouth disease.

Vaccinia or cowpox was eliminated in the diagnosis by using in each series of experiments animals that had recovered from, and were therefore immune to, that disease. Furthermore, scrapings from the lesions were used for inoculating the scrotum of guinea pigs and the cornea of rabbits, but without producing any lesions of vaccinia.

Necrotic stomatitis may likewise be eliminated, as subcutaneous inoculations of rabbits were made in a number of instances for the isolation of the *Bacillus necrophorus*, but with negative results in each case.

Mycotic stomatitis was also discarded as a possible diagnosis, as the disease contaminating the vaccine virus even in the early cases was proven to be infectious and transmissible by inoculation, which is not possible with mycotic stomatitis. Furthermore, the sheep inoculated with this virus failed to develop any indications whatsoever of a stomatitis, but instead showed well-marked and typical lesions of the feet. This latter condition is one of the peculiar though character-

istic features of foot-and-mouth disease, for while the disease attacks the mouths and less frequently the feet of cattle, it seems to be localized almost exclusively in the feet of sheep.

RELATION OF FOOT-AND-MOUTH DISEASE TO VACCINE VIRUS.

Loeffler and Froesch^a in their researches upon foot-and-mouth disease show that the surest mode of infection is by the introduction of the contents of a vesicle into the circulation. It is also possible to infect by injecting the virus into the peritoneal cavity or into the musculature or by rubbing it into a scarification of the mucous membrane. On the other hand, if the virus is introduced into or under the skin, infection is very uncertain even in cattle, which are most susceptible to the disease. Infection in the latter instance seems to occur only if there is injury to the smaller blood vessels.

Loeffler and Froesch inoculated animals (cattle) with a mixture of vaccine virus and lymph from a foot-and-mouth vesicle. The result was that the animals vaccinated with this mixture only showed local reaction of vaccinia, and did not develop foot-and-mouth disease. The authors further showed that cowpox does not protect against foot-and-mouth disease nor does foot-and-mouth disease protect against cowpox. They further observed that when animals are inoculated with a mixture of the two viruses they only sicken with the general infection of foot-and-mouth disease provided blood is drawn in the cutaneous scarifications.

Hecker,^b in charge of the Saxony commission established for the study of this disease, failed to produce foot-and-mouth disease by rubbing the virus upon the healthy skin or by tying infected cotton pads to the clefts of the feet.

Recently Starcovič^c has conducted a number of experiments with the purpose of attenuating outbreaks of foot-and-mouth disease by the inoculation of the cattle with cowpox virus. This work was based upon the report of Ory, who communicated to the Société Central de Médecine Vétérinaire in Paris that material from a natural case of horsepox inoculated by cutaneous scarification into cattle confers upon them an immunity against foot-and-mouth disease. In repeating these experiments, however, Starcovič noted that the influence of either horsepox or cowpox upon the development of foot-and-mouth disease was but slight, for while the injected animals resisted exposure for an unusually long period (eighteen to twenty days), this alone would not make such vaccination practicable. With this end in view he prepared a mixture of 2 parts of cowpox virus, 2

^a Centralblatt für Bakteriologie, etc., 1. abt., vol. 23, 1898, pp. 371-391.

^b Zeitschrift der Landwirtschaftskammer für die Provinz Sachsen, No. 3, 1899.

^c Archiva Veterinaria, Nos. 4 and 5, Vol. V, p. 203.

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parts of normal serum, and 1 part of foot-and-mouth disease lymph. By the injection of this mixture he succeeded in transmitting a very mild form of foot-and-mouth disease in 83 per cent of the cases, and even during the course of the disease the cattle were worked in the yoke.

In another series of experiments a mild or benign form of the disease was conveyed in 82 per cent of the cases. It was also observed that foot lesions developed only in 2 out of 17 cases, and these lesions were slight, while in the natural foot-and-mouth disease the foot lesions attain a proportion of from 60 to 70 or even 80 per cent.

As a result of these experiments Starcovici believes that with his mixture, which contains cowpox virus, a benign form of foot-and-mouth disease may be given, as a result of which the animals may be utilized without interruption in agricultural work.

Our experiments likewise indicate quite plainly that the foot-and-mouth infection in the glycerinated vaccine virus is dilute and attenuated. We have shown that the vaccine virus of Manufacturer B contained the infection of foot-and-mouth disease, and that this has existed at least since April 15, 1908, and probably a much longer time. However, no instance of the transmission of foot-and-mouth disease to man through vaccine virus has been recorded, and it is doubtful, in view of the evidence submitted, if it is possible to reproduce the disease in him by the cutaneous inoculation commonly used in the process of vaccination. Moreover, man is not very susceptible to the disease, and it would therefore seem that the virus thus contaminated may be characterized as undesirable rather than dangerous to man.

However, as soon as the facts became known immediate and effectual steps were taken by Surgeon-General Walter Wyman, of the United States Public Health and Marine-Hospital Service, to eradicate all this vaccine virus used in America. Under the law of July 1, 1902, the licenses of Manufacturers A and B were at once suspended, and all the suspected vaccine virus on hand was destroyed and that upon the market withdrawn, and other measures of a radical nature were taken to accomplish the desired object. In this process the intelligent and prompt cooperation of these firms is much to be commended. Further, the Hygienic Laboratory was directed by the Surgeon-General to examine at once every strain of vaccine virus upon the market to determine whether it was free from this infection. This has been done, and it may be stated that there is now upon the market no vaccine virus contaminated with the virus of foot-and-mouth disease. In fact, the contamination of Manufacturer A's vaccine was established while it was still undergoing the ripening process and before it had been placed on the market.

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Hereafter manufacturers will be required to test their virus for the presence of foot-and-mouth infection, as they are now required to test it for the presence of tetanus and other pathogenic micro-organisms. Similar control tests will be made in the Hygienic Laboratory under the law to insure the purity and potency of the vaccine virus that is found in interstate traffic.

Furthermore, additional regulations have been issued, in accordance with section 4 of the act approved July 1, 1902, having for their specific object the prevention of the importation, or the sale in interstate traffic, of vaccine virus contaminated with foot-and-mouth disease or other infections communicable to man.

CONCLUSIONS.

(1) The recent outbreak of foot-and-mouth disease in this country started from some calves used to propagate vaccine virus.

(2) The vaccine virus used on these calves has been proved to contain the infection of foot-and-mouth disease.

(3) The outbreaks of foot-and-mouth disease in 1902-3 probably had a similar origin.

(4) It is probable that the foot-and-mouth infection got into the vaccine virus in some foreign country where the disease prevailed, and was introduced into the United States through the importation of this contaminated vaccine.

(5) The symbiosis between the infections of vaccinia and foot-and-mouth disease is especially interesting. Animals vaccinated with the mixed virus, as a rule, show only the lesions of one of these diseases, namely, vaccinia; nevertheless the infectious principle of foot-and-mouth disease remains in the vaccinal eruption.

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United States Department of Agriculture,

BUREAU OF ANIMAL INDUSTRY.—Circular 148.

A. D. MELVIN, CHIEF OF BUREAU.

A PRACTICAL DEMONSTRATION OF A METHOD FOR CONTROLLING THE CATTLE TICK.¹

By W. D. HUNTER and J. D. MITCHELL,
Of the Bureau of Entomology.

INTRODUCTORY.

This circular deals with a demonstration, carried out by the Bureau of Entomology under absolutely practical conditions, of a method for controlling the cattle tick. It is believed that equally successful results can be obtained by any cattle raiser. Exactly the same method as that of this demonstration can be followed throughout the tick-infested portion of Texas, in which are found three-fifths of all the cattle below the quarantine line. Moreover, with slight modifications the plan pursued could be applied to any farm in the quarantined area.

This demonstration was conducted in Victoria County, Tex. The object was not so much to exterminate the tick as to bring it under control and avoid as far as possible the dipping of cattle, which causes a heavy expense to the cattle producers in Texas and elsewhere. Under present conditions in the southern portion of the tick area the individual ranchman as a rule does not desire to eradicate entirely the ticks from his ranch. The result of complete extermination of the ticks, of course, would be the production of nonimmune cattle that would become sick upon being removed to any locality where they would be infested by fever ticks. Unless numbers of ranchmen join together to exterminate the pest over large areas the individual would at present much rather attempt control than eradication. This is a present, practical side of the question of great importance. Of course all intelligent ranchmen are heartily in favor of the plan of total extermination that is being very successfully followed by the Bureau of Animal Industry of this Department, namely, by gradually lowering the quarantine line. The means of control described herein are chiefly of value in regions which naturally can not be reached by that plan for some years. Moreover, the means recommended will greatly assist in absolute eradication when the time comes.

PLAN.

It has been known for a long time that pastures will become free of fever ticks when cattle are kept out for a certain time. This is due

¹This circular, reporting work done by the Bureau of Entomology, is issued as a publication of the Bureau of Animal Industry by agreement between the two bureaus, since the latter has charge of the Department's work of tick eradication. Other literature on this general subject may be obtained on application to the Chief of the Bureau of Animal Industry, Washington, D. C.

altogether to the fact that these ticks can live and develop only on cattle and on a few other animals. In the absence of cattle (also horses, mules, and sheep) they must perish after a certain time.¹ These facts are taken advantage of in the so-called rotation or starvation system of controlling or eradicating ticks. This system was brought to perfection by Prof. H. A. Morgan, now director of the Tennessee Experiment Station, as a result of many years of study of the tick and experimentation while he was connected with the Louisiana State University and Agricultural and Mechanical College and Experiment Station.

LOCATION OF DEMONSTRATION PASTURE.

In a pasture of about 30,000 acres belonging to Mr. J. J. Welder, located in the northeastern portion of Victoria County, an area of about 1 mile square was selected for the demonstration. A corner of the pasture was cut off by building approximately 2 miles of fencing, giving an area of approximately 1 square mile. Purposely this small pasture was located in the most brushy and, according to Mr. Welder, who has owned the pasture for many years, the most "ticky" part. It was decided to make a severe test; to control the ticks, if possible, where they were known to be most numerous. Approximately one-fourth of the area selected was covered with live-oak runners, post oaks, and black jacks. The grass was not considered good, being largely sedge, which is not devoured readily by cattle. It was not burned during 1907. A well and a windmill were located in the area, so that the cattle were not compelled to leave for water.

DETAILS OF DEMONSTRATION.

The fence was finished July 25, 1907. On that date the cattle were all removed from the demonstration pasture, the gate was locked, and the key given to an agent of the Department. On December 12, 1907, that is, one hundred and forty days after the cattle were removed, 65 head, mostly grade Durhams, were taken without selection from the herd in the main pasture, dipped in a vat filled with a proprietary "tickicide" on the same day, and then placed in the demonstration pasture. These 65 head remained without disturbance throughout the winter and spring of 1908. In June Mr. Welder examined those in the demonstration pasture. As shown by his statement, hereinafter quoted, he was inclined to believe that the ticks had been exterminated. However, on June 26 Mr. Mitchell examined each one of the 65 cattle carefully and found a total of 7 ticks. These were on 4 animals; that is, 61 animals did not have any ticks whatever. Of the 4 animals which showed ticks one had 3 on the dewlap, one had 2 on the escutcheon, one had 1 on the dewlap, and one had 1 on the flank.

At the time of the examination just referred to Mr. Welder found the ticks so numerous on the cattle in the main pasture that he immediately gave directions for a general dipping. The outside cattle were heavily infested; no animal was free of ticks, and some of them were so excessively infested that from a distance they had the appearance of being mangy. At the same time the following of the starvation plan

¹ The cattle tick, under very exceptional conditions, may develop on the dog. This is of only remote practical importance. For a discussion of this matter see Bulletin 72, Bureau of Entomology, United States Department of Agriculture.

had reduced the number of ticks in the demonstration pasture to a negligible quantity. It would not have been necessary to dip any of the cattle if they had been as free from ticks as those in the demonstration pasture.

The results of this demonstration from the standpoint of the owner, a large and successful cattle raiser in Texas, are given in the following letter:

VICTORIA, TEX., *June 30, 1908.*

Mr. W. D. HUNTER, Dallas, Tex.

DEAR SIR: The experimental pasture was located in a portion of my pasture, in the northeastern part of Victoria County, where the brush is very heavy and where the most ticks have always been found. On visiting my large pasture recently I found the ticks were so numerous that I immediately gave orders for a general dipping. At the same time I examined the cattle in the demonstration pasture and to my surprise did not see a single tick. Mr. J. D. Mitchell, however, informs me that after examining each one of the animals he found a total of 7 ticks on the 65 head. I am greatly pleased with the result of the experiment, which I consider is of great value to cattlemen. If I had had a double fence around the experimental pasture I believe that no ticks would be found in it at this time. I believe that the few found on the cattle came from ticks dropped along the fence. Moreover, if all my cattle were as free of ticks as those in the demonstration pasture at this time I would not be put to the expense of dipping.

Respectfully,

J. J. WELDER.

It was the opinion of both Mr. Welder and Mr. Mitchell that the condition of the cattle in the demonstration pasture was excellent. Nevertheless, there was not a great difference in condition between the inside cattle and outside cattle on June 26. Undoubtedly this condition would have been changed in favor of the cattle in the demonstration area in a short time, on account of the development of the ticks on the outside cattle. Moreover, it is to be noted that the grass in the demonstration pasture was not burned during the summer of 1907, while that in the main pasture was burned. This improved the forage for the outside cattle and made the grass on the demonstration pasture much poorer. The grass there was not burned for the reason that it was desired to do nothing toward controlling the ticks except the starvation process. The burning of the area would have complicated matters and made it impossible to determine how much effect was due to the fire and how much to starvation. As a matter of fact, the burning of the outside pasture undoubtedly destroyed numbers of ticks and thereby made the test the more severe.

GENERAL APPLICATION OF RESULTS.

It is considered by the Bureau of Entomology that this demonstration is of great practical importance. The results can undoubtedly be applied with slight modifications to all the conditions under which cattle are raised in the South. It will be noted that the process of dipping was a necessary part of the plan. This would not generally be a handicap, however, since dipping vats have been put up or are being put up by the majority of the large ranchers in Texas. On a small scale hand greasing or spraying the cattle would serve the same purpose as the dipping in the present case.

The results of this demonstration are more striking on account of the peculiar conditions as regards ticks that obtained in Texas during the winter and spring of 1907-8. On account of very dry weather during the summer and fall of 1907 the numbers of ticks were reduced every-

where in Texas to far below the normal. This general reduction probably makes the contrast between the cattle in the demonstration pasture and outside less than it would be under normal conditions. With the usual number of ticks the infestation outside would have been much heavier in June than it was, and it probably would have been necessary to dip the cattle at least as early in 1908 as was done in 1907, which was about the 20th of May.

The question might be raised as to where the few ticks found on the cattle in the demonstration pasture could have come from. It is the opinion of Mr. Welder and the writers that these few ticks were the progeny of individuals which were dropped by the outside cattle near the fence, which crawled up the fence posts and thence were taken up by the cattle on the inside. The building of a double fence would have eliminated such a contingency. Nevertheless, as already pointed out, the plan of the demonstration was on an absolutely practical basis. Under usual ranch conditions the building of a double fence would be impracticable.

The question will probably occur to the reader as to the length of time it may be necessary to keep cattle out of any certain area to reduce the ticks to an inconsiderable number. The time the pasture was free of cattle in this demonstration was one hundred and forty days. It was assumed that some of the cattle might have dropped ticks on the day they were removed. Therefore, it was desired to determine how long seed ticks from eggs deposited by an individual dropped at that time could have lived. This was done by placing engorged ticks in glass tubes about the time of the removal of the cattle, August 1. The ticks used in the experiment lived for one hundred and twenty days, none being found after November 29. To be on the safe side, twenty days were added to this period, making the one hundred and forty days during which the cattle were kept from the demonstration pasture. Information regarding this method and the means to be followed to give experimental ticks natural conditions has been published by the Bureau of Entomology in Bulletin 72, which may be had for 15 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., March 30, 1909.

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Issued September 14, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 149.

A. D. MELVIN, CHIEF OF BUREAU.

A COLD-STORAGE EVAPORIMETER.^a

By MILO M. HASTINGS,
Scientific Assistant, Animal Husbandry Office.

INTRODUCTION.

In the cold storage of food products the control of temperature has been reduced to a very satisfactory basis. The thermometer as a means of temperature measurement is practically perfect. Other than temperature, the most important factor in the success of such operations is the humidity or amount of evaporation, but heretofore there has been no instrument for determining humidity that would meet the demands of this industry.

Animal products in particular suffer loss from unfavorable conditions of atmospheric moisture. In the case of eggs, for example, if the air of the storage room is too dry the eggs lose weight by evaporation and are thereby seriously impaired in quality. On the other hand, if the air surrounding the eggs approaches too closely to the saturation point, even for a short period, fungous growths develop upon the eggs and packing material, imparting a musty flavor to the eggs. The end to be attained in egg storage, therefore, is to reduce evaporation as much as possible without causing mustiness, and it is important to have some means by which the evaporating power of a cold-storage room may be accurately determined. An instrument devised by the writer and constructed for this purpose is described in the following pages. It has been tested in two of the largest egg-storage plants in Chicago with good results, and it is believed to be applicable also to other branches of the storage industry.

^a United States patent (No. 454280) on the apparatus herein described has been granted under the act of Congress of March 3, 1883, so that the apparatus may be used by the Government of the United States, or any of its officers or employees in the prosecution of work for the United States, or by any person in the United States, without the payment of royalty.

When water is exposed to the air it evaporates; in other words, invisible particles of water vapor pass into the atmosphere. Like other gaseous matter, these vapor particles exert a certain definite pressure which increases more and more as the number of particles increases. Ultimately, however, as the evaporation proceeds, and supposing the vapor particles are not carried away, a maximum vapor pressure is reached, called the saturation pressure. When a condition of saturation exists, particles of vapor still continue to be given off by the water just the same as before, but this evaporation is just counterbalanced by an equal number of particles passing from the vapor back into the liquid, so that a state of equilibrium at the maximum pressure is constantly maintained.

The saturation pressure increases with temperature. At 212° F. the vapor pressure equals the normal atmospheric pressure, viz, 30 inches of mercury, and at this temperature and pressure water boils, as we say. At cold-storage temperatures the vapor pressure is much less, as, for example, 0.180 inch of mercury at 32° F.

When the temperature of saturated water vapor is lowered water is generally formed by condensation. This occurs in nature as cloud, fog, rain, snow, etc., except that vapor wholly devoid of dust or other minute foreign particles, which when present, act as nuclei for the condensation, may require to be cooled somewhat below the point of saturation before condensation actually occurs. When thus undercooled the vapor is said to be supersaturated.

At a given temperature the pressure of the vapor in the air may vary from nothing up to the saturated pressure for that temperature. Suppose, for example, that at a temperature of 32° F. the actual vapor pressure is 0.135 inch. This would be only three-fourths of 0.180, the saturated pressure at that temperature. The term "absolute humidity" is used to mean the actual vapor pressure and sometimes the weight of a unit volume of vapor. The term "relative humidity" is used to mean the ratio between the actual pressure of the vapor present and that required for saturation at the same temperature. In the foregoing example this would be the ratio between 0.135 and 0.180; that is, three-fourths, or 75 per cent. Both of these terms, though long used, are confusing as misapplied to cold-storage practice. A table which has been widely used in the cold-storage trade gives the relative humidities for egg rooms at different temperatures, the figures being based on a constant absolute humidity. As the saturation deficit changes more rapidly when the absolute humidity is held constant than when the relative humidity is held constant, this table gives a result diametrically the opposite of what its author evidently intended, i. e., a uniform rate of evaporation. That the error was not

discovered in practice is due to the practical uniformity of temperatures at which eggs are held. What we wish to know is the rate of evaporation. This is best expressed by the difference between the actual vapor pressure and the saturation vapor pressure of water at the same temperature. In the foregoing case this is the difference between 0.180 and 0.135; that is, 0.045. This difference is called the saturation deficit.

For example: Room A at a temperature of 25° F. has a vapor pressure of 0.104; room B at 28° has a pressure of 0.120; room C at 45° has a pressure of 0.238. At 25° the saturation vapor pressure is 0.130. The relative humidities would therefore be: Room A, $0.104 \div 0.130 = 80$ per cent; room B, $0.120 \div 0.150 = 80$ per cent; room C, $0.238 \div 0.298 = 79.8$ per cent. But the saturation deficits would be: A, $0.130 - 0.104 = 0.026$; B, $0.150 - 0.120 = 0.030$; C, $0.298 - 0.238 = 0.060$. As these last figures show the difference between the pressure of the vapor in the air and that required for saturation, they indicate approximately by Dalton's law the rate at which evaporation would take place. Thus, room C with practically the same relative humidity as room B would shrink a product twice as fast.

PRINCIPLE OF THE EVAPORIMETER.

If some substance be dissolved in water the saturation vapor pressure of the solution is lowered to an amount dependent upon the nature of the substance used and the strength of the solution. The vapor pressure of a solution, like that of pure water, changes with the temperature and always bears nearly a constant ratio to that of pure water at the same temperature. Thus a solution that has a vapor pressure of 0.090 at 32° F., which is half the pressure of water at that temperature, would have a pressure of 0.065 at a temperature of 25° F.—one-half that of water at that temperature.

When vapor at any given pressure is in contact with a neutral^a surface, condensation, that is, dew, frost, etc., will be deposited upon the surface whenever its temperature is below the saturation temperature that corresponds to the vapor pressure as it actually exists.

Hygroscopic substances like hair, wool, sulphuric acid solutions, and a great many other bodies are not neutral surfaces, but have the power themselves to absorb and give off vapor. With all such bodies

^a A neutral surface in this connection is one that is chemically inert to water, such as clean or polished metal surfaces, for example. Strictly speaking, it may be a question whether an absolutely neutral surface exists, except pure water itself. All other surfaces may in greater or less degree either absorb or condense moisture before the saturation temperature is reached, or else have to be cooled, at least slightly, below the point of condensation before dew is actually deposited.

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there is a certain more or less definite equilibrium vapor pressure at which absorption and evaporation equalize each other. When the vapor pressure around one of these bodies is below the equilibrium point, evaporation from the body will occur, but when the pressure is above this point the body will absorb moisture from the medium.

If we have vapor at a pressure of 0.200, water in one receptacle at a temperature such that the saturation pressure is 0.250 and an acid solution in another receptacle whose equilibrium vapor pressure is 0.150, then the water will evaporate, but the acid will absorb moisture and at nearly the same rate. On the other hand, if we prepare a solution whose equilibrium pressure is 0.200 at the particular temperature that prevails, then such a solution will neither gain nor lose in the presence of vapor at a pressure of 0.200. If the vapor pres-

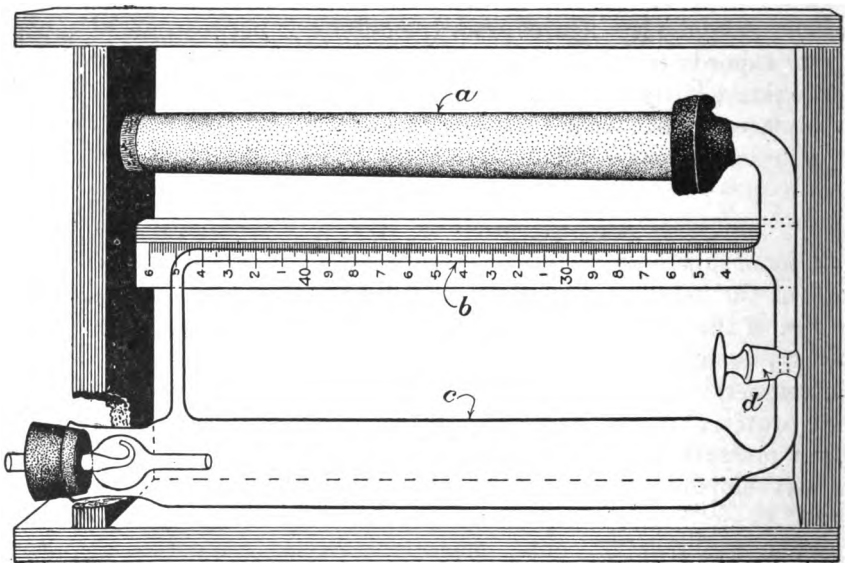


FIG. 1.—The cold-storage evaporimeter: *a*, Porous tube; *b*, reading tube; *c*, reservoir; *d*, stopcock.

sure of the air changes the change will immediately be shown in the consequent beginning of evaporation or condensation.

It follows that with a standard solution and an instrument to measure these changes we would have a reliable guide for the regulation of humidity. The cold-storage evaporimeter devised by the writer is based on these principles.

DESCRIPTION OF THE EVAPORIMETER.

The essential parts of this instrument are:

1. A porous porcelain tube (fig. 1, *a*) through which the liquid may be exposed to the air. (In the writer's experiments a Pasteur filter

[Cfr. 149]

tube was used.) The volume of liquid in this tube remains constant, the fluctuation due to evaporation or condensation being registered in the reading tube connected with the porous tube. This porcelain tube must be kept in a horizontal position and must be kept above the level of the liquid in other portions of the apparatus. The liquid will be maintained in the porous tube by capillary attraction, while if this tube were held lower than the other portions of the apparatus, pressure would cause a seepage of liquid through the filter tube.

2. A graduated reading tube (*b*) of such bore that the changes in volume of the liquid may be readily observed. (A tube of 3 mm. inside diameter was used by the writer.) This tube empties into the reservoir, and gives a double passageway, so that the instrument may be readily filled and emptied.

3. A reservoir (*c*), provided with a check bulb to allow freedom of air pressure without leaking of the liquid.

4. A stopcock (*d*) by which the amount of liquid in the porous tube may be regulated so as to keep the surface within the reading scale.

5. A suitable supporting frame.

The device used to contain the solution is similar to a water-containing evaporimeter described by Livingston (1906) of the Desert Laboratory of the Carnegie Institution.

STANDARD SOLUTION USED.

Sulphuric acid is recommended as the most suitable liquid to use in the evaporimeter. The ordinary commercial acid that can be secured at any drug store is satisfactory. This is diluted with water until the mixture assumes the specific gravity desired. The specific gravity must be read with a hydrometer graduated to thousandths when the liquid is at a temperature of exactly 32° F. This can easily be done if the acid is mixed in a cold room and both water and ice (or pipe frost) are used in diluting it. Care should be taken in handling the acid, as, if it is mixed too rapidly with water, enough heat will be generated to crack glass vessels. The acid should be poured slowly into the water. Water should never be poured into concentrated acid.

Enough acid of a desired strength may be mixed at one time to allow many changes of the solution in the evaporimeter. A gallon or half-gallon bottle should be used to hold the prepared acid and should be kept in a room of the same temperature as that in which it is to be used. The acid bottle should be kept tightly closed.

The following table gives the specific gravity of the acid solution, its saturation vapor pressure, the corresponding equilibrium, relative humidity, and saturation deficit, all at 32° F.

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Table showing specific gravity of aqueous sulphuric acid, saturation vapor pressure, equilibrium, relative humidity, and saturation deficit, at 32° F.^a

Specific gravity.	Saturation vapor pressure at 32° F.	Equilibrium, relative humidity.	Saturation deficit.	Specific gravity.	Saturation vapor pressure at 32° F.	Equilibrium, relative humidity.	Saturation deficit.
	<i>Inches of mercury.</i>	<i>Per cent.</i>			<i>Inches of mercury.</i>	<i>Per cent.</i>	
1.00	0.1800	100.0	0.0000	1.16	0.1573	87.4	0.0227
1.01	.1792	99.5	.0008	1.17	.1542	85.7	.0258
1.02	.1784	99.1	.0016	1.18	.1512	84.0	.0288
1.03	.1776	98.7	.0024	1.19	.1481	82.3	.0319
1.04	.1767	98.2	.0033	1.20	.1450	80.5	.0350
1.05	.1756	97.5	.0044	1.21	.1417	78.7	.0383
1.06	.1744	96.9	.0056	1.22	.1380	76.7	.0420
1.07	.1732	96.2	.0068	1.23	.1343	74.6	.0457
1.08	.1721	95.6	.0079	1.24	.1306	72.5	.0494
1.09	.1706	94.8	.0094	1.25	.1268	70.4	.0532
1.10	.1691	93.9	.0109	1.26	.1225	68.0	.0575
1.11	.1678	93.2	.0122	1.27	.1180	65.5	.0620
1.12	.1662	92.3	.0138	1.28	.1136	63.1	.0664
1.13	.1641	91.2	.0159	1.29	.1092	60.7	.0708
1.14	.1619	89.9	.0181	1.30	.1050	58.3	.0750
1.15	.1598	88.8	.0202				

^a This table is prepared by the Biochemic Division of the Bureau of Animal Industry and is based on experimental results by C. Dieterici as published in Wiedemann's "Annalen der Physik und Chemie," vol. 50, 1893, pp. 60 and 69, recalculated to pressure in inches of mercury at a barometric pressure of 30 inches and on the basis that the saturation pressure of water at 32° F. is 0.180 inch of mercury.

^b Water.

This table can be computed for any temperature as follows: The relative humidity for a given specific gravity of acid (always measured at 32° F.) remains the same at all temperatures. The absolute humidity or vapor pressure of the acid is determined by multiplying the relative humidity by the vapor pressure of pure water at the given temperature. The saturation deficit is determined by subtracting the acid pressure from the pressure of water.

EXAMPLE: At 28° F. the relative humidity of 1.20 acid is 0.805.

0.805×0.150 (the vapor pressure of water) = 0.1207 = saturation pressure at 28°.

$0.150 - 0.1207 = 0.0293$, the saturation deficit at 28° F.

The specific gravity of acid solution required to give certain saturation deficits from common egg-room temperatures are given in the following table:

Table showing specific gravity of sulphuric acid solution for certain saturation deficits at temperatures given.

Temperature.	Saturation deficit.				
	0.010.	0.020.	0.030.	0.040.	0.050.
° F.	<i>Sp. gr.</i>	<i>Sp. gr.</i>	<i>Sp. gr.</i>	<i>Sp. gr.</i>	<i>Sp. gr.</i>
29	1.104	1.161	1.198	1.230	1.259
30	1.100	1.157	1.193	1.225	1.254
31	1.097	1.153	1.188	1.220	1.247
32	1.094	1.149	1.184	1.215	1.241
33	1.092	1.145	1.180	1.210	1.236

In practice, as the temperature of a plant is uniform, it would be sufficient to define the humidity by referring to the specific gravity of acid used. Thus a plant with dead air might be held [Cir. 149]

at a temperature of 32° F. and an evaporimeter test of 1.19 acid, while another plant with a blower system might find that best results could be obtained with a temperature of 30° F. and an evaporimeter test of 1.17 acid.

OPERATION OF THE INSTRUMENT.

Filling.—Hold the evaporimeter with the mouth of the reservoir upward and pour in the solution until the reservoir is three-fourths full. Push the stopper in tightly, holding the reservoir tube firmly in the other hand. See that the hook in the catch bulb is turned toward the porous tube. Now open the stopcock and tilt the frame so that the solution will flow into the porous tube. By tilting the instrument back and forth the porous tube is entirely filled. Allow the instrument to remain a minute or two in the position for draining the solution into the porous tube, until the tube is thoroughly soaked and liquid begins to drip through. Be sure that all bubbles are out of evaporation and reading tubes by holding for a moment with the tubes in a vertical position, with the stopcock at the top. Now close the stopcock and hold the instrument as in figure 1. This is the working position of the evaporimeter. After the globules of liquid which have gathered on the outer surface of the porous tube have disappeared (they may be wiped off with a clean cloth), the liquid may be drawn back into the reading scale by carefully turning the stopcock.

Location.—The instrument may be set on a shelf or hung by cords of sufficient length to allow free manipulation. Drafts of air blowing upon the evaporimeter do not affect its accuracy in determining whether the air is above or below the vapor pressure of the liquid, but, with a given difference of pressure, currents of air will accelerate the rate of change, which fact is also true of the evaporation of the products in storage. By adapting the strength of the solution to the vapor pressure of the air, the evaporimeter may be made to determine the humidity in the center of a pile of cases as well as in a main draft of air, and in the hands of a careful investigator the instrument may be used to determine both the efficiency of air circulation and the evaporating power of various air currents. In the average plant, however, with these factors fixed by the equipment, it will be sufficient to locate the instrument in a center aisle, or if a forced-draft system be used, in the main draft, and from practical experience determine what saturation deficit in this location will give the best results.

Reading.—The instrument when in use must always have the porous tube horizontal and above the reading tube. The readings may be taken as often as desirable and the movement figured on an hourly, daily, or weekly basis (daily would seem preferable). The level of the liquid must be adjusted with the stopcock as often as necessary to keep it from running off the reading scale. When more

liquid must be run into the reading tube the instrument must be tipped until the reading tube is below the reservoir. This will cause a slight quantity of liquid to ooze through the porous tube, and this must then be allowed to pass back into the tube before the reading is taken, or an error will be introduced. It must be remembered that change of temperature of any liquid causes change of volume, and if the instrument is taken into a warm room or filled with warm liquid time must be allowed for it to reach the same temperature as the air of the storage room before readings are of value. Bubbles will sometimes collect in the evaporation tube and introduce an error in reading. These are due to air held in solution and will not occur except after fresh solution is poured into the evaporimeter.

Refilling.—The instrument would not need refilling if the strength of the solution could be so nicely balanced with the average vapor pressure of the air that the liquid would play back and forth within the confines of the reading tube. In practice this is impracticable; with a reading tube of 3 millimeters bore the error introduced by the weakening or concentration of the solution is such as to require the refilling of the instrument every time the total movement in one direction has amounted to two tube lengths. The frequency with which this must be done will vary with the efficiency of the air control, and the interval may be from three days to three months. The rate of change in strong drafts, as before stated, will be greatly accelerated. This, if predominantly in one direction, will cause too rapid a change in the strength of solution for best results. In such cases it is best to protect a portion of the porous tube from contact with the air by wrapping with waxed paper or other acid-proof material. By this means the rate of change may be adapted to the location of the instrument until a mean is struck, which will give readings sufficient to indicate the changes in humidity and yet affect but slowly the strength of the solution.

Change of solution.—When it is desired to introduce a solution of a different strength it will be necessary to empty the instrument, rinse it, and then fill the tube with water and allow it to stand inverted for a few hours until the porous tube is thoroughly washed. It must then be allowed to dry out before the fresh solution is put in. For ordinary purposes and where the variations are not great it will be sufficient to drain the tube, refill it with fresh acid solution, and then allow a quantity of this acid to filter through the tube.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., June 25, 1909.

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Issued August 9, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 150.

A. D. MELVIN, CHIEF OF BUREAU.

REGULATIONS GOVERNING ENTRANCE TO THE VETERINARY INSPECTOR EXAMINATION.

Effective on and after September 1, 1909.

By and with the consent and approval of the United States Civil Service Commission, the following regulations are hereby promulgated with reference to the matriculation examination and course of instruction in veterinary science at veterinary schools and colleges required to educate and qualify persons for the civil-service examination for the position of veterinary inspector in the United States Department of Agriculture, Bureau of Animal Industry. These regulations also include a list of the schools and colleges at present accredited and qualified to supply the graduates eligible to enter the above-mentioned civil-service examination.

It is distinctly to be understood that no power to direct or control the work of the veterinary schools or colleges is claimed by the Civil Service Commission or by the Department of Agriculture. The regulations which follow merely indicate what are the requirements of the Government as to veterinary schools and colleges whose graduates are admitted to examinations for veterinary inspectors in the Bureau of Animal Industry.

REGULATION I.—Matriculation.

1. A matriculation examination shall be adopted by each veterinary college, the minimum requirements of which shall be equivalent to the second-grade examination as published in the United States Civil

Service Manual of Examinations, supplemented by United States history and geography of the United States and its possessions. Such examination will therefore comprise:

1. Spelling.
2. Arithmetic.
3. Letter writing.
4. Penmanship.
5. Copying from plain copy.
6. United States history.
7. Geography of the United States and its possessions.

2. An applicant having a diploma from a recognized college or a normal or high school shall be eligible for admission to a veterinary college without examination.

REGULATION II.—Dates of holding matriculation examinations.

The entrance examination shall be conducted on one or more specifically advertised dates under the supervision of the dean, director, or, in the case of State institutions, by the official examining board. The last entrance examination shall be held not later than fifteen days subsequent to the advertised annual opening of the college year, and no time credit shall be allowed to students admitted after that date.

REGULATION III.—Filing of matriculation examination papers.

The questions and answers of both successful and unsuccessful applicants shall be kept on file by the institution for at least five years subsequent to the examination of the applicants.

REGULATION IV.—Grading of matriculation examination papers.

Applicants shall be graded upon a basis of 100 per cent, and a grade of not less than 70 per cent shall qualify for admission.

REGULATION V.—Certificate of matriculation examination.

Any person applying for admittance to the freshman class or for advanced standing in a veterinary college shall present before being enrolled a certificate showing that he has passed the matriculation examination required by these regulations, and in no case shall he be admitted without such certificate.

REGULATION VI.—Subjects constituting course of instruction.

The appended list of subjects shall constitute the course of instruction required as a minimum for veterinary colleges. These numerically indicated shall be known as the major subjects, and those designated by letters shall be under the direction of the professors in charge of the allied major subjects.

1. Anatomy:
 - (a) Histology (veterinary).
 - (b) Zoology (veterinary).
 - (c) Embryology.
2. Physiology:
 - (a) Principles of nutrition.
 - (b) Hygiene.
 - (c) Animal locomotion.
3. Zootechnics:
 - (a) Breeds and breeding.
 - (b) Judging.
 - (c) Feeds and feeding.
 - (d) Dairy inspection.
 - (e) Jurisprudence.
4. Chemistry:
 - (a) Elementary physics.
 - (b) Physiological chemistry—analysis of milk, urine, etc.
5. Materia medica:
 - (a) Botany (medical).
 - (b) Pharmacy.
 - (c) Toxicology.
6. Pathology:
 - (a) Bacteriology.
 - (b) Parasitology.
 - (c) Post-mortem examination.
 - (d) Meat inspection.
 - (e) Laboratory diagnosis.
7. Practice of comparative medicine:
 - (a) Diagnostic methods and clinics.
 - (b) Therapeutics.
 - (c) Control of infective diseases.
8. Surgery:
 - (a) Surgical diagnosis and clinics.
 - (b) Surgical restraint.
 - (c) Soundness.
 - (d) Lameness.
 - (e) Shoeing and balancing.
 - (f) Dentistry.
 - (g) Obstetrics.

REGULATION VII.—Length of course.

The course of instruction when given during the day shall cover a period of three years of not less than six and one-half months in each year, exclusive of final examinations and holidays; and this course of instruction shall have as a minimum 150 days of actual teaching in each year and a minimum of 3,000 actual teaching hours for the entire three years. The course of instruction when given at night (after 6 p. m.) shall cover a period of three years of not less than eight and one-half months in each year, exclusive of final examinations and holidays. Such course of night instruction shall have

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as a minimum 200 days of actual teaching in each year, and a minimum of 3,000 actual teaching hours for the entire three years, including at least 150 hours of practical clinical instruction, which shall be given in the daytime.

REGULATION VIII.—Minimum number of hours in course.

Anatomy, major subject:

Lectures	200	
Laboratory	300	
		500
Histology—		
Lectures	40	
Laboratory	100	
		140
Embryology—		
Lectures	10	
Laboratory	20	
		30
Zoology—		
Lectures	20	
Laboratory	20	
		40
Total for subject.....		710

Physiology, major subject:

Lectures	80	
Laboratory	20	
		100
Principles of nutrition.....	10	
Hygiene	10	
Animal locomotion	5	
		25
Total for subject.....		125

Zootechnics, major subject:

Breeds and breeding.....	30	
Judging	30	
Feeds and feeding.....	30	
Dairy inspection	10	
Jurisprudence	10	
		110
Total for subject.....		110

Chemistry, major subject:

Lectures	50	
Laboratory	150	
		200
Physics (elementary)		20
Physiological chemistry—		
Urine analysis.....	10	
Milk analysis.....	10	
		20
Total for subject.....		240

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Materia medica, major subject:

Lectures.....	70
Pharmacy, lectures, and laboratory.....	50
Botany.....	30
Toxicology.....	10
Total for subject.....	160

Pathology, major subject:

Lectures.....	40
Laboratory.....	100
Bacteriology—	140
Lectures.....	20
Laboratory.....	90
Parasitology—	110
Lectures.....	50
Laboratory.....	10
Post-mortem examination.....	60
Meat inspection.....	10
Laboratory diagnosis.....	50
Total for subject.....	420

Practice of comparative medicine, major subject:

Lectures.....	250
Diagnostic methods and clinics.....	300
Therapeutics.....	100
Control of infective diseases.....	25
Total for subject.....	675

Surgery, major subject:

Lectures.....	100
Surgical exercises.....	80
Surgical diagnosis and clinics.....	180
Surgical restraint.....	200
Soundness.....	30
Lameness.....	20
Shoeing and balancing.....	50
Dentistry (lectures).....	10
Obstetrics.....	20
Total for subject.....	560

Recapitulation.

Total hours for anatomy group.....	710
Total hours for physiology group.....	125
Total hours for zootechnics group.....	110
Total hours for chemistry group.....	240

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Total hours for materia medica group.....	160
Total hours for pathology group.....	420
Total hours for practice of comparative medicine group.....	675
Total hours for surgery group.....	560
Total hours, three-year course.....	3,000

REGULATION IX.—Transfer of time from one subject to another of same group.

An elasticity may be allowed in the apportionment of the time to the different subjects (or their divisions) under each group to the extent that not more than 25 per cent may be omitted from the time of any one subject, providing this deducted time be added to some other subject or subjects in the same group.

REGULATION X.—Grading of course.

The course shall be graded in such manner as to avoid unnecessary repetition of lectures or instruction to the same student. For example, a student, while freshman, should be required to complete a definitely outlined course in such subjects as anatomy, histology, chemistry, etc. When advanced to the junior class he should either drop the studies of his freshman year and take up new work, or he may continue the same subject; for example, anatomy, along advanced lines of instruction.

REGULATION XI.—Number of veterinarians.

On the faculty of every veterinary college there shall be at least five graduate veterinarians from accredited veterinary colleges teaching major subjects, each of whom shall have had not less than one year's additional training in some accredited veterinary college or three years' experience in teaching or in practicing veterinary science subsequent to graduation from an accredited veterinary college.

REGULATION XII.—Qualifications of teaching veterinarians.

Not more than three of the five veterinarians in charge of major subjects on each college faculty shall be graduates of any one veterinary college, unless they have had at least one year's additional training in another accredited veterinary college.

REGULATION XIII.—Subjects taught by veterinarians.

The five veterinarians on the faculty of each veterinary college shall have charge of the following major subjects: (1) Anatomy; (2) [Cir. 150.]

Practice of Comparative Medicine; (3) Surgery, and any two of the following three subjects: Pathology, Materia Medica, and Physiology.

REGULATION XIV.—Evidence of attendance.

At the end of the college year each student is entitled to and shall receive a written statement giving the length of time spent in each study during the session and the grade received therein. This statement, or definite evidence of credit, shall be exacted from a student before he is given advanced standing in any veterinary college.

REGULATION XV.—Transfer of students.

A student transferring from one accredited veterinary college to another accredited veterinary college shall be given credit only for such time and courses (lectures and laboratory) as he has successfully completed in the institution previously attended. No one of the colleges herein enumerated shall give credit to any student for any work done at colleges not included in this list.

REGULATION XVI.—Applicants from colleges not veterinary.

1. An applicant who has successfully completed at least two years' work in a reputable college of human medicine, dentistry, pharmacy, or agriculture, and who brings an official and explicit certificate describing his course of study and scholarship, and also a certificate of honorable dismissal, shall not be admitted to advanced classes or standing in a veterinary college except as otherwise provided in section 2 of this regulation, but may be given credit for such subjects as have been successfully completed in such colleges if, in the subjects for which credit is sought, said colleges maintain a standard of instruction similar and equal to the minimum standard of requirements established by these regulations.

2. An applicant from a State agricultural college having upon its faculty one or more graduate veterinarians giving a special course in veterinary science may be given a time credit of one year, providing he has a certificate from the college authorities that he has successfully completed at least 1,200 hours in studies as follows:

Anatomy :

Lectures	200	
Laboratory	300	
		500

Histology :

Lectures	40	
Laboratory	100	
		140,

Embryology :

Lectures	10	
Laboratory	20	
		30

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Zoology :		
Lectures	20	
Laboratory	20	
		40
Physiology :		
Lectures	80	
Laboratory	20	
Principles of nutrition	10	
Hygiene	10	
Animal locomotion	5	
		125
Zootechnics :		
Breeds and breeding	30	
Judging	30	
Feeds and feeding	30	
Dairy inspection	10	
		100
Chemistry :		
Lectures	50	
Laboratory	150	
Physics (elementary)	20	
Milk analysis	10	
		230
Botany		35
Total hours preveterinary course		1,200

REGULATION XVII.—Agricultural and medical college graduates.

1. A graduate of the regular four-year agricultural course in an agricultural college having upon its faculty a qualified veterinarian giving a regular course of instruction in veterinary science may be given a time credit of one year, but this credit shall apply only to such subjects as he has successfully completed, provided the course of instruction in said agricultural college, in the subjects for which credit is sought, is similar and equal to the minimum standard of requirements in the course indicated in these regulations.

2. A graduate of a reputable college of human medicine on presentation of a diploma from such college may be given a time credit of one year, but this credit shall apply only to such subjects as he has successfully passed, provided the course of instruction in said medical college in the subjects for which credit is sought is similar and equal to the minimum standard of requirements in the course indicated in these regulations.

REGULATION XVIII.—One graduation period only.

No veterinary college shall have more than one graduation period yearly, nor shall diplomas be issued except at the close of the regular college year.

[Cir. 150.]

REGULATION XIX.—Requirements for graduation.

1. A candidate for graduation shall have attained the age of 21 years and attended three full college years in a veterinary college herein recognized (except as otherwise provided in Regulations XVI and XVII); the last year of attendance must have been at the college to which he applies for graduation.

2. He must have successfully completed the course of study and passed all the final examinations in the subjects indicated in these regulations.

3. If he fails to pass satisfactorily in subjects representing in time 25 per cent or more of his senior year, these subjects must again be taken in full with a succeeding class before he can be graduated.

REGULATION XX.—Information for Department of Agriculture.

1. All veterinary colleges shall promptly furnish to the Department of Agriculture a copy of their annual announcements and of all other publications relative to the courses of instruction offered.

2. They shall also furnish: (1) Not later than twenty days after the opening of the first session of each college year, a complete list of their matriculates by classes; and (2) within ten days after the close of the college year, a complete list of the last graduating class.

REGULATION XXI.—Eligibility for United States civil-service examination.

Graduates of the accredited veterinary colleges herein listed shall be eligible at all times for the United States civil-service examination for employment as veterinary inspectors in the Bureau of Animal Industry, subject to the other requirements of the civil-service rules as to fitness, etc.

REGULATION XXII.—Not eligible to civil service.

Hereafter no undergraduate or other person who has not received a diploma from an accredited veterinary college shall be permitted to take the civil-service examination for the position of veterinary inspector.

REGULATION XXIII.—Supervision of veterinary colleges.

The Department of Agriculture shall maintain such supervision of the work of the veterinary colleges as shall enable it to secure the requisite information to determine whether such colleges are faithfully complying with the minimum standard of requirements indicated in these regulations.

[Cir. 150.]

REGULATION XXIV.—List of accredited veterinary colleges.

The following list of institutions is approved in lieu of the one previously in force. There will be added thereto, as occasion may arise, upon recommendation of the Department of Agriculture or upon proof made to the Civil Service Commission that any school or college has qualified as provided in these regulations for eligibility, any other veterinary schools or colleges whose courses of study are found to be satisfactory to the Department or to the Commission according to the standards herein established.*

Chicago Veterinary College.

Cincinnati Veterinary College.

Colorado State College of Agriculture and the Mechanic Arts,
Veterinary Department.

Indiana Veterinary College.

Iowa State College, Veterinary Department.

Kansas City Veterinary College.

Kansas State Agricultural College, Veterinary Department.

McKillop Veterinary College.

New York-American Veterinary College.

New York State Veterinary College.

Ohio State University, College of Veterinary Medicine.

San Francisco Veterinary College.

State College of Washington, Veterinary Department.

United States College of Veterinary Surgeons.

University of Pennsylvania, Veterinary Department.

The Grand Rapids Veterinary College is excluded until it complies with these regulations, except as follows: Those graduates who have studied veterinary science at this college for three years may be admitted to examinations.

The Ontario Veterinary College is excluded until it complies with these regulations, except as follows: Those graduated during or prior to 1897 may be admitted to examinations.

Graduates of the following-named colleges, which are not now in session, will be admitted to examinations:

Columbia University, Veterinary School, Washington, D. C.

Harvard University, School of Veterinary Medicine, Boston, Mass.

McGill University, Veterinary Department, Montreal, Canada.

National Veterinary College, Washington, D. C.

Graduates of the following-named foreign colleges will be admitted to examinations:

Glasgow Veterinary College, Glasgow, Scotland.

Royal Veterinary College, London, England.

* The colleges are arranged in alphabetical order.

Royal Veterinary College of Ireland, Dublin, Ireland.
 Royal (Dick) Veterinary College, Edinburgh, Scotland.
 The New Veterinary College, Liverpool, England.
 Veterinary College of Lemberg, Austria.

Approved.

JAMES WILSON,
Secretary of Agriculture.

Approved (by direction of the Civil Service Commission).

JOHN C. BLACK,
President.

WASHINGTON, D. C., *July 31, 1909.*

[Cir. 150.]

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United States Department of Agriculture,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 150-A.

A. D. MELVIN, CHIEF OF BUREAU.

LIST OF ACCREDITED VETERINARY COLLEGES.

Revision of List Contained in Regulation XXIV, Bureau of Animal Industry Circular 150, "Regulations Governing Entrance to the Veterinary Inspector Examination."

The following list of accredited veterinary colleges, graduates of which are eligible for the civil-service examination for the position of veterinary inspector in the United States Department of Agriculture, Bureau of Animal Industry, is hereby approved in lieu of that published in Regulation XXIV of Bureau of Animal Industry Circular 150, "Regulations Governing Entrance to the Veterinary Inspector Examination."¹

Alabama Polytechnic Institute, College of Veterinary Medicine.
Chicago Veterinary College.
Cincinnati Veterinary College.
Colorado State College, Division of Veterinary Science.
George Washington University, College of Veterinary Medicine.
Grand Rapids Veterinary College.²
Indiana Veterinary College.
Iowa State College, Division of Veterinary Medicine.
Kansas City Veterinary College.
Kansas State Agricultural College, Veterinary Department.
McKillip Veterinary College.
New York-American Veterinary College.
New York State Veterinary College.
Ohio State University, College of Veterinary Medicine.
San Francisco Veterinary College.
State College of Washington, Veterinary Department.
University of Pennsylvania, School of Veterinary Medicine.
University of Toronto, Ontario Veterinary College, to include only those graduated during or prior to 1897.

¹ This list is subject to change. The failure of any college to comply with the provisions of the regulations will necessitate removal from the list.

² To include only those graduates who have pursued the study of veterinary medicine at this college or in some other accredited college for three years.

Graduates of the following-named colleges which are not now in session will be admitted to examinations:

Columbian University, Veterinary School, Washington, D. C.
 Harvard University, School of Veterinary Medicine, Boston, Mass.
 McGill University, Veterinary Department, Montreal, Canada.
 National Veterinary College, Washington, D. C.

Graduates of the following-named foreign colleges will be admitted to examinations:

Glasgow Veterinary College, Glasgow, Scotland.
 Royal Veterinary College, London, England.
 Royal Veterinary College of Ireland, Dublin, Ireland.
 Royal (Dick) Veterinary College, Edinburgh, Scotland.
 The New Veterinary College, Liverpool, England.
 Veterinary College of Lemberg, Austria.

Approved.

JAMES WILSON,
Secretary of Agriculture.

Approved (by direction of the Civil Service Commission).

JOHN C. BLACK,
President.

WASHINGTON, D. C., *August 22, 1911.*

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